CONICAL SCANNING MICROWAVE IMAGER/SOUNDER (CMIS)

Sensor Requirements Document (SRD)

for

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) SPACECRAFT AND SENSORS

Prepared by

Associate Directorate for Acquisition
NPOESS Integrated Program Office

This document is in two sections—this section contains unique information. Information shared by all sensors is in the Common section.

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Table of Contents for CMIS SRD Common Section

The following paragraphs of the CMIS SRD can be found in the SRD "Common Section". The following SRD Common Section Table of Contents is for reference only. Page numbers have been intentionally omitted.

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1 SCOPE

1.1 IDENTIFICATION

This Sensor Requirements Document sets forth the requirements of the CONICAL SCANNING MICROWAVE IMAGER/SOUNDER which is part of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and is hereinafter referred to as the CMIS.

1.2 SENSOR OVERVIEW

The purpose of the CMIS is to collect global microwave radiometry and sounding data. These data will be processed to produce microwave imagery and other specialized meteorological and oceanographic data using algorithms developed in conjunction with the flight hardware. These data will be processed from Raw Data Records (RDRs) into Sensor Data Records (SDRs), Temperature Data Records (TDRs) and Environmental Data Records (EDRs). Data will be disseminated to users worldwide by the Department of Defense, Department of Commerce and the European Meteorological Organization.

1.3 DOCUMENT OVERVIEW

This document contains all performance requirements for the CMIS sensor suite. The contractor should use this document as the basis of a proposed sensor suite specification. The documentation listed in Section 2.0 follows an approach of minimum specifications and standards. The contractor may add to or revise the documents listed in Section 2.0 in coordination with the government. Section 3, Sensor Requirements, provides the detailed requirements for the CMIS sensor suite. This section includes the CMIS performance characteristics, design and construction, and related specifications.

The term "(**TBD**)" applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term "(**TBS**)" means that the government will supply the missing information in the course of the contract. The term "(**TBR**)" means that the requirement is subject to review for appropriateness by the contractor or the government. The government may change "(**TBR**)" requirements in the course of the contract.

Section 4, Quality Assurance and Testing Provisions, provides for the testing, verification and quality assurance for the CMIS sensor suite. Of particular note in this section is the Verification Cross Reference (Section 4.3) and the related matrix (Appendix H). Section 5, Preparation and Delivery, covers preservation, packaging, and marking for the CMIS sensor suite. Appendix A contains a definition of the terms used throughout the document. Appendix B, NPOESS Survivability Requirements, is classified and will be made available after contract award. Appendix C provides characteristics of the SDRs, and is presently (TBR). Appendix D of the TRD contains the NPOESS EDR requirements. Appendix E contains the RDRs and EDRs required for each Central and Field Terminal (TBR). Appendix F defines the acronyms and abbreviations used throughout the document. Appendix G describes Potential Pre-planned Product Improvements. Appendix H is the Verification Cross Reference Matrix (**TBD**).

1.3.1 CONFLICTS

SRDC1.3.1-1
In the event of conflict between any referenced documents and the contents of this specification, the contents of this specification shall be the superseding requirements.

SRDC1.3.1-2
In the event of a conflict involving the external interface requirements, or in the event of any other unresolved conflict, the contracting officer shall determine the order of precedence.

1.3.2 REQUIREMENT WEIGHTING FACTORS

The requirements stated in this specification are not of equal importance or weight. The following three paragraphs define the weighting factors incorporated in this specification.

a. ***Shall*** designates the most important weighting level; that is, mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.
b. ***Should*** designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the *should* requirements does not require approval of the contracting officer.
c. ***Will*** designates the lowest weighting level. These *will* requirements designate the intent of the government and are often stated as examples of acceptable designs, items and practices. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the contracting officer and does not require documented technical substantiation.

1.4 SYSTEM CLASSIFICATIONS N/A

2 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is (TBR).

SPECIFICATIONS:

Military

DOD-E-83578A May 96	General Specification for Explosive Ordnance for Space Vehicles
Mil-A-83577B Feb 88	Moving Mechanical Assemblies for Space Launch Vehicles
MIL-C-24308 Apr 97	General Specification for Connectors, Electric, Rectangular, Non-Environmental, Miniature, Polarized Shell, Rack, and Panel
MIL-C-38999 Dec 97	Connectors, Receptacle, Electrical, Circular, Breakaway Wall Mounting Flange, Removable Crimp Contacts, Sockets, Series III, Shell Size 25, Metric

STANDARDS:

Federal

FED-STD-209E Sep 92	Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones

Military

MIL-STD-461D Jan 93	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462D Jan 93	Measurement of Electromagnetic Interference Characteristics
MIL-STD-975 Aug 94	NASA Standard Electrical, Electronic, and Electro-mechanical (EEE) Parts List, Revision M, 5 May 1998
MIL-STD-1540C Sep 94	Test Requirements for Launch, Upper Stage, and Space Vehicles
MIL-STD-1541A	Electromagnetic Compatibility Requirements for Space

Dec 87	Systems
MIL-STD-1553B Jan 96	Digital Time Division Command/Response Multiplex Data Bus

Department of Commerce/NOAA None (TBR)

OTHER PUBLICATIONS:

Regulations

AFM 91-201 7 Oct 94	Explosive Safety Standards
EWR 127-1 31 Mar 95	Eastern and Western Range Safety Requirements

Handbooks None (TBR)

Bulletins None (TBR)

Other

GPS ICD 200 REV C 19 January 1995	"NAVSTAR GPS Space Segment/Navigation User Interface"(U)
GPS ICD 203, REV B 22 Dec 1993	"NAVSTAR GPS SA/AS Requirements"(U) SECRET

(Contractors requiring copies of specifications, standards, handbooks, drawings, and publications in connection with specified acquisition functions should obtain them from the contracting activity or as directed by the contracting officer.)

2.2 NONGOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1.

SPECIFICATIONS: None (TBR)

STANDARDS:

CCSDS 203.0-B-1 Jan 87	CCSDS Recommendations for Space Data System Standards. Telecommand, Part 3: Data Management Service, Architectural Definition, Issue 1
CCSDS 701.0-B-2 Dec 87	CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification

ISO/TC 209 (ISO/DIS 14644-1) Jan 97	Cleanrooms and Associated Controlled Environments
National Aerospace Standard (NAS) 411 Rev 2, 29 Apr 94	Hazardous Materials Management Program
IEEE Std 1394a-2000 05/31/2000	IEEE Standard for a High Performance Serial Bus—Amendment 1

DRAWINGS: None (TBR)

OTHER PUBLICATIONS: None (TBR)

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because various parts of the SRD refer to them.

SPECIFICATIONS:

Military None (TBR)

STANDARDS:

ANSI STD X3.159-1989	Programming Language--C (If C is used as a programming language, then this standard is applicable. Also standardized as the equivalent ISO/IEC 9899:1990. The 1994 amendment is excluded.)
DOD 5200.28-STD Mar 88	Department of Defense Trusted Computer System Evaluation Criteria
EIA/IEEE J-STD 016 30 Sep 95	Standard for Information Technology, Software Life Cycle Processes, Software Development, Acquirer-Supplier Agreement
MIL-STD-129M 1 Jun 93	Marking for Shipment and Storage Notice 1, 15 Sep 89
MIL-STD-882c Jan 93	System Safety Program Requirements
MIL-STD 961D Aug 95	DoD Standard Practice for Defense Specifications, w/ Notice 1

MIL-STD-1246C Apr 94	Military Standard Product Cleanliness Levels and Contamination Control Program
MIL-STD-1522A May 84	Standard General requirements for Safe Design and Operation of Pressurized Missile and Space Systems Notice 2: 20 Nov 86; Notice 3: 4 Sep 92
MIL-STD-1542B Nov 91	Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
MIL-STD-1543B Oct 88	Reliability Program Requirements for Space and Launch Vehicles
MIL-STD-1547A Dec 92	Parts and Materials Program for Space and Launch Vehicles
ANSI/ISO/IEC 8652: 1995	FIPS 119-1 Ada
TM-86-01	Technical Manual Contract Requirements

Department of Commerce

DOC Sep 95 Edition Sep 95	National Telecommunications and Information Administration, Manual of Regulations for Federal Radio Frequency Management

NOAA

S24.801 Nov 72	Preparation of Operations and Maintenance Manuals, revised Apr 97
S24.806 Jan 86	Software Development, Maintenance, and User Documentation, revised Apr 94
S24.809 Dec 89	Grounding Standards

NASA

PPL-21 March 1995	Preferred Parts List, Goddard Space Flight Center (Updated May 1996)

SP-R-0 022A (JSC) 9 Sep 74	General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application

OTHER PUBLICATIONS:

Regulations None (TBR)

Handbooks

DOD-HDBK-263B (date)	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, Equipment
MIL-HDBK-340 1 Jul 85	Application Guidelines for MIL-STD-1540B
DOD-W-83575 Jun 96	Gen Spec for Wiring Harness, Space Vehicle, Design and Testing
MIL-I-46058	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
1985	Handbook of Geophysics and Space Environments
AFM 15-111 1 Sep 96	Surface Weather Observations
CR 84-03 (June 1984)	Handbook for Sea Ice Analysis and Forecasting, Prepared by W. J. Stringer, D. G. Barnett and R. H. Godin, Naval Env. Prediction Res. Facility

Bulletins None

Other

TRD for NPOESS (current version)	Technical Requirements Document (TRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
IRD for NPOESS (current version)	Interface Requirements Document (IRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft
WMO/OMM/BMO-- No. 259. TP. 145, Supplement No. 5 (April 1989).	World Meteorological Organization Sea-Ice Nomenclature

IORD for NPOESS 28 Mar 96	Integrated Operational Requirements Document (IORD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
ASTME-595-93 (current version)	Standard Test method for Total Mass Loss and Collected Volatile Condensable Materials for Outgassing in a Vacuum Environment
Attachment C S-480-80 Revised December 1994	AMSU-A Instrument Performance and Operation Specification (for the EOS/METSAT Integrated Programs); NASA GSFC
SYS/AMS/J0105/ BAE 03 Feb 1993	AMSU-B Instrument System Specification (British Aerospace)

(Technical society and technical association specifications and standards are generally available from reference libraries. They are also available in technical groups and using federal agencies. Contact the contracting officer regarding any referenced document not readily available from other sources.)

3 SENSOR REQUIREMENTS

3.1 DEFINITION

3.1.1 SENSOR DESCRIPTION

The Conical Scanning Microwave Imager/Sounder (CMIS) will be part of the NPOESS System. It will consist of all ground and spaceborne hardware and software necessary to perform calibrated, microwave radiometric measurements from space and the software and science algorithms necessary to process, on the ground, these measurements into a format consistent with the requirements of the assigned Environmental Data Records (EDRs).
Identified below are the Primary EDRs assigned to CMIS.

PRIMARY EDRs

Atmospheric Vertical Moisture Profile
Atmospheric Vertical Temperature Profile
Imagery
Sea Surface Winds (Speed and Direction)
Soil Moisture - Surface (Cloudy)
Sea Surface Temperature
Precipitable Water
Precipitation (Type/Rate)
Pressure Profile (Surface/Profile)
Total Water Content
Cloud Base Height
Cloud Ice Water Path
Cloud Liquid Water
Snow Cover/Depth (Cloudy)
Fresh Water Ice Edge Motion (Cloudy)
Ice Surface Temperature (Cloudy)
Sea Ice Age and Sea Ice Edge Motion (Cloudy)
Surface Wind Stress
Land Surface Temperature
Vegetation/Surface Type

SECONDARY EDRs

NONE

The requirements for each of the above EDRs are discussed in Paragraph 3.2.1.1.1.1. Please note that, for some of the EDRs listed in Paragraph 3.2.1.1.1.1, the Threshold and/or Objective values are different from the values specified in Appendix D of the TRD; where changes have been made, the requirements of Paragraph 3.2.1.1.1.1 take precedence.

3.1.2 SYSTEM SEGMENTS N/A

3.1.3 SPECIFICATION TREE

The partial specification tree for the System is shown in Figure 3.1.3.

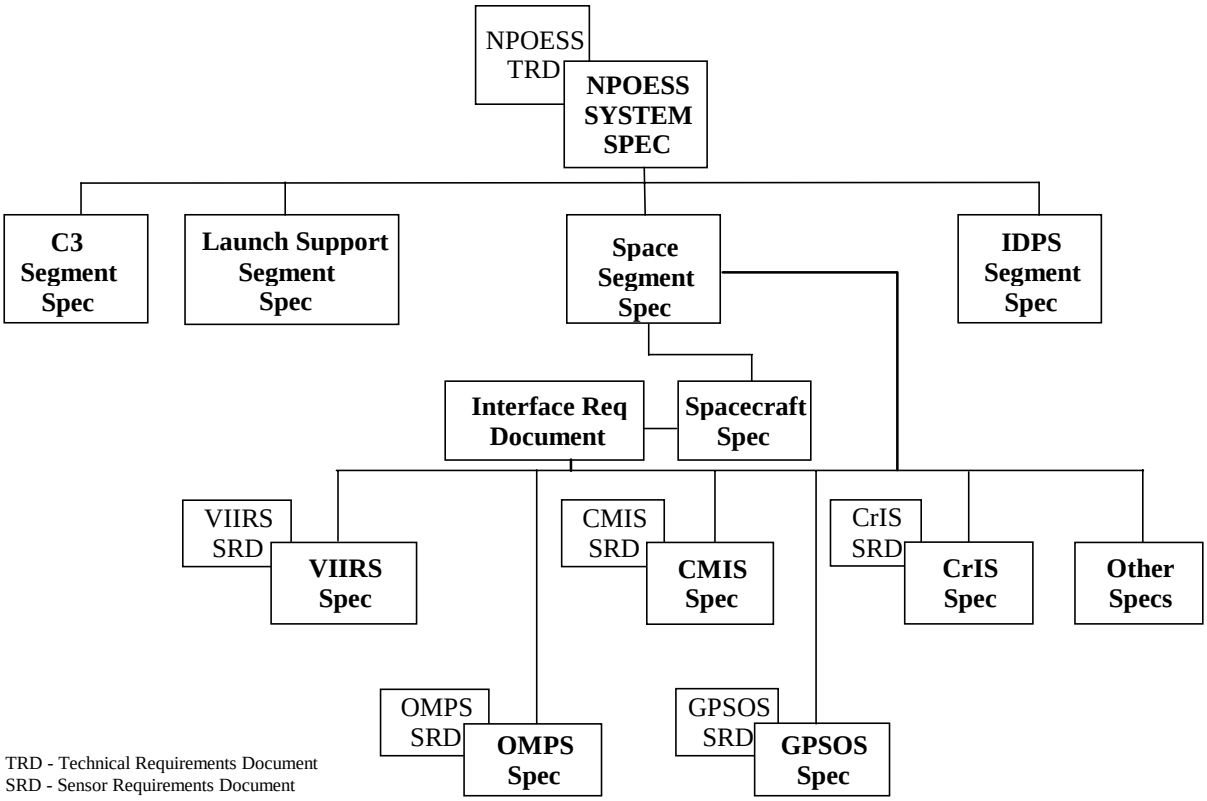

Figure 3.1.3 Partial Specification Tree

3.1.4 TOP-LEVEL FUNCTIONS

3.1.4.1 Top-Level Sensor Functions

The top-level functions which the CMIS instrument will perform include the following:

- Measurement of scene brightness temperatures,
- On-orbit calibration,
- Preparation and transmission of RDR data to the spacecraft,
- Reporting instrument health and status,
- Reception and appropriate response to command and control data.

3.1.4.2 Top-Level Algorithm Functions

SRDC3.1.4.2-1
Science algorithms shall process CMIS data, and other data as required, to provide the Environmental Data Records assigned to CMIS.

3.1.5 SENSOR MODES

3.1.5.1 Sensor Off Mode

SRDC3.1.5.1-1
In the Sensor Off mode, no power shall be supplied to the sensor.

3.1.5.2 Sensor Operational Mode

SRDC3.1.5.2-1
The sensor shall be in full functional configuration during this mode.

SRDC3.1.5.2-2
Mission and housekeeping data shall be collected and transmitted.

SRDC3.1.5.2-3
Calibrations shall be done during regular operations.

3.1.5.3 Sensor Diagnostic Mode

SRDC3.1.5.3-1
The Sensor Diagnostic Mode shall include troubleshooting and software updates.

3.1.5.4 Sensor Safe Hold Mode

In the Safe Hold Mode, health and status data are collected and transmitted. Mission and calibration data are not collected. The Safe Hold Mode is a power conservation mode.

SRDC3.1.5.4-1
The Sensor shall accept a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event.
The C&DH will issue power conservation re-configuration commands to the sensors, via the data bus, that will place the sensor in a safe configuration. The return to the Sensor Operations Mode requires ground intervention.

SRDC3.1.5.4-2
In this mode most subsystems shall be turned off, with survival heaters activated.

3.1.5.5 CMIS Specific Sensor Modes (TBR)

SRDC3.1.5.5-1
The CMIS contractor shall recommend to the Government additional CMIS-specific modes. The recommended modes may include System Test Mode, Storage Mode,

Transport Mode, Pre-launch Mode, Launch and Ascent Mode, Deployment and Initialization Mode, and Calibration and Validation Mode.

3.1.6 OPERATIONAL AND ORGANIZATIONAL CONCEPT

3.1.6.1 Expendable Launch Vehicle Concept N/A

3.1.6.2 Launch Operations Concept

3.1.6.2.1 Pre-launch

The CMIS sensors will be delivered and integrated onto the specified satellite platforms. During integration various CMIS verification tests will be required.

3.1.6.2.2 Launch

During launch and injection to the operational orbit, the CMIS subsystems will be powered off, unless recommended otherwise by the vendor, in order to provide protection from the launch and injection environments. Spacecraft telemetry to monitor vehicle status will be provided during launch and injection; transmission of launch vehicle telemetry may be used to satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations will be used to the extent practicable during the injection phase. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments will be initiated by memory command. Early orbit check-out will be conducted at the NPOESS primary SOC in Suitland, MD.

SRDC3.1.6.2.2-1
The contractor shall identify all CMIS specific requirements for power, telemetry, etc. during launch and ascent.

3.1.6.3 On-orbit Operational Concept

The NPOESS spacecraft will operate in a near circular, sun-synchronous orbit. The nominal orbit for the spacecraft is 833 km altitude, 98.7 degree inclination. The orbit will be a “precise” orbit (i.e., altitude maintained to ± 17 (TBR) km, ±0.05 (TBR) degrees inclination, nodal crossing times maintained to ± 10 minutes throughout the mission lifetime) to minimize orbital drift (precession). NPOESS must be capable of flying at any equatorial node crossing time. However, the nominal configuration is with the satellite orbits equally spaced, with 0530 and 1330 nodal crossing times for the U.S. Government spacecraft and 2130 for the EUMETSAT Meteorological Observation Satellite (METOP) spacecraft.
The satellite will only be flown in orbits that keep sunlight off of the cold space side of the spacecraft. Because of natural variations in the orbit, the 10 minute nodal crossing time constraint, and variations in the solar illumination of the satellite, this will preclude the spacecraft from flying in orbits within about 30 (TBR on satellite contractor) minutes of noon.

SRDC3.1.6.3-1
Deleted.

SRDC3.1.6.3-2
Specified EDR performance shall be obtained for any of the orbits described in paragraph 3.1.6.3, except for orbits within about 30 (TBR on satellite contractor) minutes of noon.

3.1.6.3.1 On-orbit Tests

The initial on-orbit period will be devoted to a complete spacecraft checkout and the calibration and performance verifications of the payloads, including the CMIS. The spacecraft and payload performance verification tests may be repeated at appropriate times during the operational phase of the mission.

3.1.6.3.2 On-orbit Operations (TBR)

SRDC3.1.6.3.2-1
On-orbit, the CMIS shall continuously perform all required measurements. Real-time data are continuously sent to the spacecraft for broadcast so that users within the field of view of the spacecraft data transmitters may receive the data.

SRDC3.1.6.3.2-2
The CMIS shall receive commands from the satellite as required to support the NPOESS mission.

SRDC3.1.6.3.2-3
The CMIS sensor shall be capable of operating for 21 days (with an objective of 60 days) without additional commands, i.e., autonomous operation.

3.1.7 MISSIONS

The mission of CMIS is to provide an enduring capability for providing measurements on a global basis of various atmospheric, land, and sea parameters of the Earth using microwave remote sensing techniques. The CMIS instrument will collect relevant information from a spaceborne platform, and utilize scientific algorithms to process that information on the ground into designated Environmental Data Records; CMIS consists of all spaceborne hardware, any ground-based test and support equipment, and the associated ground-based science algorithms. The Environmental Data Records will be disseminated to military, civil, and international users of the data throughout the world. The specific measurement requirements which CMIS must perform are identified in the assigned Primary EDRs and Secondary EDRs. These requirements have been prepared in coordination with, and approved by, the Departments of Defense and Commerce.

3.2 SENSOR SUITE CHARACTERISTICS

3.2.1 PERFORMANCE CHARACTERISTICS

SRDC3.2.1-1
The performance characteristics of the CMIS shall be developed by the vendor based upon the data product requirements of the EDRs assigned to the CMIS and any other requirements specified herein.

SRDC3.2.1-2
Sensor level requirements shall be derived by the contractor based on a flowdown of EDR requirements to instrument performance requirements using the contractor's EDR science algorithms and any specification provided in the CMIS SRD.

SRDC3.2.1-3
If a derived requirement conflicts with an explicit requirement and/or another requirement, the most stringent requirement shall be satisfied.

SRDC3.2.1-4
Unless otherwise specified, all performance requirements within Section 3.2.1 shall be met over the design service life of the CMIS and under all operational environmental conditions.

3.2.1.1 Performance Requirements

3.2.1.1.1 EDR Requirements

SRDC3.2.1.1.1-1
The environmental data records listed in Section 3.2.1.1.1.1 are the measurement requirements which shall be satisfied by CMIS. Please note that the EDR requirements specified in Paragraph 3.2.1.1.1.1 may have different Thresholds and/or Objectives than the values contained in Appendix D of the NPOESS TRD.
Note: Supplemental information concerning conventions/general EDR requirements can be found in Section 40.1 of Appendix D and are to be followed unless found to be in conflict with modifications and clarifications of EDR requirements identified in this section.

SRDC3.2.1.1.1-2
In the event of conflict, the values specified in Paragraph 3.2.1.1.1.1 shall take precedence.

SRDC3.2.1.1.1-3
As a minimum, the EDR requirements shall be satisfied at the threshold level.

SRDC3.2.1.1.1-4
In the event the requirements for an EDR cannot be fully satisfied, the contractor shall identify the requirements which are not fully satisfied, and specify the conditions when they will not be satisfied.

SRDC3.2.1.1.1-5
The contractor shall also specify the conditions under which it recommends delivering an EDR which is incomplete and/or of degraded quality, but which is still of potential utility to one or more users.

SRDC3.2.1.1.1-6
The CMIS contractor shall identify specifications for any data required from other sources in order to meet the attribute requirements of the primary EDRs assigned to the CMIS sensor.

3.2.1.1.1.1 EDR Requirements

Identified below are the EDRs which CMIS must satisfy. The attribute numbering is consistent with Appendix D of the TRD except for the preface letter ("C") which indicates it is a unique requirement in this SRD. Any difference in these attributes take precedence over Appendix D values as they reflect an intentional requirements allocation to this sensor.

SRDC3.2.1.1.1.1-1
For the EDRs appended with "(cloudy)" listed in paragraph 3.1.1, above, CMIS shall satisfy the EDR Thresholds associated with cloudy conditions under all measurement conditions, i.e., in clear conditions, cloudy conditions, or any amount of cloud cover.

SRDC3.2.1.1.1.1-2
The requirements for data to be provided by other sensors to CMIS (e.g., other sensor Secondary EDRs) shall be defined by the CMIS contractor no later than 60 days prior to each of the other sensors' Systems Requirements Review (SRR).

SRDC3.2.1.1.1.1-3
Requirements for the following Primary EDRs shall be satisfied using sensing data acquired by the CMIS and science algorithms developed by the CMIS contractor. The science algorithm may or may not require the use of additional data from other than CMIS.

SRDC3.2.1.1.1.1-4
The contractor shall advise the government of data requirements from sources external to CMIS.

Atmospheric Vertical Moisture Profile **TRD App D Section 40.2.1**

An atmospheric vertical moisture profile is a set of estimates of the average mixing ratio in three-dimensional cells centered on specified points along a local vertical. The mixing ratio of a sample of air is the ratio of the mass of water vapor in the sample to the mass of dry air in the sample. For requirements in which both a percentage value and an absolute value are supplied in the table below, the requirement is to be interpreted as the greater of the values.

Para. No.		Thresholds	Objectives
C40.2.1-1	a. Horizontal Cell Size	15 km	2 km
C40.2.1-2	b. Horizontal Reporting Interval	15 km (TBR)	2 km
C40.2.1-3	c. Vertical Cell Size	2 km	2 km
	d. Vertical Reporting Interval		
C40.2.1-4	1. Surface to 850 mb	20 mb	5 mb
C40.2.1-5	2. 850 mb to 100 mb	50 mb	15 mb
C40.2.1-6	e. Horizontal Coverage	Global	Global
C40.2.1-7	f. Vertical Coverage	Surface to 100 mb	Surface to 100 mb
C40.2.1-8	g. Measurement Range	0 - 30 g/kg	0 - 30 g/kg
	h. Measurement Uncertainty (expressed as a percent of average mixing ratio in 2 km layers)		
	Clear		
C40.2.1-9	1. Surface to 600 mb	20 % or 0.2 g/kg (TBR)	10 %
C40.2.1-10	2. 600 mb to 300 mb	35 % or 0.1 g/kg (TBR)	10 %
C40.2.1-11	3. 300 mb to 100 mb	35 % or 0.04 g/kg (TBR)	10 %
	Cloudy		
C40.2.1-12	4. Surface to 600 mb	20 % or 0.2 g/kg (TBR)	10 %
C40.2.1-13	5. 600 mb to 300 mb	40 % or 0.1 g/kg (TBR)	10 %
C40.2.1-14	6. 300 mb to 100 mb	40 % or 0.04 g/kg (TBR)	10 %
C40.2.1-15	i. Mapping Uncertainty	5 km	1 km
C40.2.1-16	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Atmospheric Vertical Temperature Profile **TRD App D Section 40.2.2**

An atmospheric temperature profile is a set of estimates of the average atmospheric temperature in three-dimensional cells centered on specified points along a local vertical.

Para. No.		Thresholds	Objectives
C40.2.2-1	a. Horizontal Cell Size		
	1. Surface to 20 mb	40 km	5 km
	2. 20 mb to 0.01 mb	200 km	200 km
C40.2.2-2	Deleted		
C40.2.2-3	Deleted		
C40.2.2-4	Deleted		
C40.2.2-5	b. Horizontal Reporting Interval		
	1. Surface to 20 mb	40 km	5 km
	2. 20 mb to 0.01 mb	200 km	200 km
	c. Vertical Cell Size		
	Clear		
C40.2.2-6	1. Surface to 300 mb	1 km	(TBD)
C40.2.2-7	2. 300 mb to 30 mb	3 km	(TBD)
C40.2.2-8	3. 30 mb to 1 mb	5 km	(TBD)
C40.2.2-9	4. 1 mb to 0.01 mb	5 km	(TBD)
	Cloudy		
C40.2.2-10	5. Surface to 700 mb	1 km	(TBD)
C40.2.2-11	6. 700 mb to 300mb	1 km	(TBD)
C40.2.2-12	7. 300 mb to 30 mb	3 km	(TBD)
C40.2.2-13	8. 30 mb to 1 mb	5 km	(TBD)
C40.2.2-14	9. 1 mb to 0.01 mb	5 km	(TBD)
	d. Vertical Reporting Interval		
C40.2.2-15	1. Surface to 850 mb	20 mb	15 mb
C40.2.2-16	2. 850 mb to 300 mb	50 mb	15 mb
C40.2.2-17	3. 300 mb to 100 mb	25 mb	15 mb
C40.2.2-18	4. 100 mb to 10 mb	20 mb	10 mb
C40.2.2-19	5. 10 mb to 1 mb	2 mb	1 mb
C40.2.2-20	6. 1 mb to 0.1 mb	0.2 mb	0.1 mb
C40.2.2-21	7. 0.1 mb to 0.01 mb	0.02 mb	0.01 mb
C40.2.2-22	e. Horizontal Coverage	Global	Global
C40.2.2-23	f. Vertical Coverage	Surface to 0.01 mb	Surface to 0.01 mb
C40.2.2-24	g. Measurement Range	180-335K	162-335K (TBR)
C40.2.2-25	Not used		
	h. Measurement Uncertainty		
	Clear		
C40.2.2-26	1. Surface to 700 mb	1.6 K / 1 km layers	0.5K / 1km
C40.2.2-37	2. 700 mb to 300 mb	1.5 K / 1 km layers	0.5K / 1 km
C40.2.2-27	3. 300 mb to 30 mb	1.5 K / 3 km layers	0.5K / 1km
C40.2.2-28	4. 30 mb to 1 mb	1.5 K / 5 km layers	0.5K / 1km
C40.2.2-29	5. 1 mb to 0.01 mb	3.5 K / 5 km layers	0.5K / 1km
	Cloudy		
C40.2.2-30	5. Surface to 700 mb	2.5 K / 1 km layers (TBR)	0.5K / 1km
C40.2.2-31	6. 700 mb to 300 mb	1.5 K / 1 km layers (TBR)	0.5K / 1km
C40.2.2-32	7. 300 mb to 30 mb	1.5 K / 3 km layers (TBR)	0.5K / 1km
C40.2.2-33	8. 30 mb to 1 mb	1.5 K / 5 km layer (TBR)	0.5K / 1km
C40.2.2-34	9. 1 mb to 0.01 mb	3.5 K / 5 km layers (TBR)	0.5K / 1km
C40.2.2-35	i. Mapping Uncertainty	5 km	1 km
C40.2.2-36	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Imagery **TRD App D Section 40.2.3**

SRDC3.2.1.1.1.1-5
Brightness temperature data from each microwave channel shall be available for display at the sampled resolution. The threshold horizontal spatial resolution (HSR) is to be consistent with the performance of the related EDRs. The display capability for all imagery should be consistent with the dynamic range of any CMIS channel.

Para. No.		Thresholds	Objectives
	a. Horizontal Spatial Resolution		
C40.2.3.1-1	1. Global	Consistent with related EDRs	(TBD)
C40.2.3.1-2	b. Horizontal Reporting Interval	Consistent with related EDRs	(TBD)
C40.2.3.1-3	c. Horizontal Coverage	Global	Global
C40.2.3.1-4	Not Used		
C40.2.3.1-5	d. Measurement Range	Dynamic range of all measurement channels	Dynamic range of all measurement channels
C40.2.3.1-6	e. Measurement Uncertainty (TBR)	Derived	Derived
C40.2.3.1-7	f. Mapping Uncertainty	3 km (TBR)	(TBD)

Sea Surface Temperature (SST) **TRD App D Section 40.2.4**

Sea surface temperature (SST) is defined as the skin temperature of the ocean surface water. The measured radiances should enable the derivation of both skin and surface layer (1 meter depth) sea surface temperature to the specifications listed below, though an EDR algorithm is only required for skin temperature.

Para. No.		Thresholds	Objectives
C40.2.4-1	a. Horizontal Cell Size	50 km (TBR)	25 km (TBR)
C40.2.4-2	Deleted		
C40.2.4-3	Deleted		
C40.2.4-4	Deleted		
C40.2.4-5	b. Horizontal Reporting Interval	50 km	25 km (TBR)
C40.2.4-6	c. Horizontal Coverage	Oceans	Oceans
C40.2.4-7	Deleted		
C40.2.4-8	d. Measurement Range	271 K - 313 K	271 K - 313 K
C40.2.4-9	e. Measurement Uncertainty	0.5 K	0.1 K
C40.2.4-10	f. Measurement Accuracy	(TBD)	0.1 K
C40.2.4-11	g. Measurement Precision	(TBD)	0.1K
C40.2.4-12	h. Mapping Uncertainty	5 km	1 km (TBR)
C40.2.4-13	Deleted		
C40.2.4-14	Deleted		
C40.2.4-15	Deleted		
C40.2.4-16	i. Swath Width	1700 km	3000 km (TBR)

Sea Surface Winds (Speed and Direction) **TRD App D Section 40.2.5**

SRDC3.2.1.1.1.1-6 The contractor shall report the measurement accuracy and measurement precision of the solution representing the closest ambiguity and the associated skill of the algorithm for selecting that solution.

Atmospheric wind speed and direction at the sea/atmosphere interface. This parameter is to be reported at 10 meters (neutral stability winds).

Para. No.		Thresholds	Objectives
C40.2.5-1	a. Horizontal Cell Size	20 km	1 km
C40.2.5-2	b. Horizontal Reporting Interval	20 km	1 km
C40.2.5-3	c. Horizontal Coverage	Oceans	Oceans
	d. Measurement Range		
C40.2.5-4	1. Speed	3 - 25 m/s	1 - 50 m/s
C40.2.5-5	2. Direction	0 - 360 deg	0 - 360 deg
	e. Measurement Accuracy		
C40.2.5-6	1. Speed	2 m/s or 20 % of true value, whichever is greater	1 m/s or 10 % of true value, whichever is greater
C40.2.5-7	2. Direction	20 deg for wind speeds greater than 5 m/s. 20deg(TBR) for wind speeds from 3 - 5 m/s	10 deg
	f. Measurement Precision		
C40.2.5-8	1. Speed	1 m/s	1 m/s
C40.2.5-9	2. Direction	10 deg	10 deg
C40.2.5-10	g. Mapping Uncertainty	5 km	1 km
C40.2.5-11	h. Swath Width	1700 km	3000 km (TBR)

Soil Moisture **TRD App D Section 40.2.6**

Total liquid water in the soil or in a surface layer over soil. The threshold requirement is to measure soil moisture within a thin layer at the surface (0.1 cm) for bare soil in regions with known soil types, as well as, soil moisture for vegetated terrain. The objective is to measure a moisture profile for any soil, whether bare or not, and whether or not the soil type is known.

Para. No.		Thresholds	Objectives
C40.2.6-1	a. Horizontal Cell Size	40 km	1 km
C40.2.6-2	Deleted		
C40.2.6-3	b. Horizontal Reporting Interval	40 km	2 km
C40.2.6-4	c. Vertical Cell Size	Skin Layer	5 cm
C40.2.6-5	d. Vertical Reporting Interval	N/A (single value reported)	5 cm
C40.2.6-6	e. Horizontal Coverage	Land	Land
C40.2.6-7	f. Vertical Coverage	Skin layer	0 to -80 cm
C40.2.6-8	g. Measurement Range (volumetric)	0 – 100% (TBR)	0 – 100%
C40.2.6-9	h. Measurement Uncertainty (volumetric)	10% (TBR)	5%
C40.2.6-10	Deleted		
C40.2.6-11	i. Mapping Uncertainty	3 km	1 km
C40.2.6-12	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Precipitable Water **TRD App D Section 40.3.3**

The requirements below apply under both clear and cloudy conditions. Precipitable water is defined as the total equivalent water in a vertical column of the atmosphere per unit cross-sectional area.

Para. No.		Thresholds	Objectives
C40.3.3-1	a. Horizontal Cell Size	25 km (TBR)	1 km
C40.3.3-2	b. Horizontal Reporting Interval	25 km (TBR)	1 km
C40.3.3-3	c. Horizontal Coverage	Global	Global
C40.3.3-4	d. Measurement Range	0 - 75 mm	0 - 100 mm
C40.3.3-5	e. Measurement Accuracy	Greater of 10 % or 2 mm	1 mm
C40.3.3-6	f. Measurement Precision	1 mm	1 mm
C40.3.3-7	g. Mapping Uncertainty	3 km	0.1 km
C40.3.3-8	h. Swath Width	1700 km (TBR)	(TBD)

Precipitation (Type, Rate) **TRD App D Section 40.3.4**

The required data products are precipitation rate and identification of type as rain or ice. The requirements in the table below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.4-1	a. Horizontal Cell Size	15 km (TBR)	0.1 km
C40.3.4-2	b. Horizontal Reporting Interval	15 km (TBR)	0.1 km
C40.3.4-3	c. Horizontal Coverage	Global	Global
	d. Measurement Range		
C40.3.4-4	1. Precipitation Rate	0 - 50 (TBR) mm/hr	0 - 250 mm/hr
C40.3.4-5	2. Precipitation Type	Rain and ice	Rain and ice
C40.3.4-6	e. Measurement Accuracy, Precip. Rate	2 mm/hr	2 mm/hr
C40.3.4-7	f. Measurement Precision, Precip. Rate	1 mm/hr	1 mm/hr
C40.3.4-8	g. Correct Typing Probability, Precip. Type	(TBD) %	(TBD) %
C40.3.4-9	h. Mapping Uncertainty	3 km	0.1 km
C40.3.4-10	i. Swath Width	1700 km (TBR)	(TBD)

Pressure Profile (TBR) **TRD App D Section 40.3.5**

A pressure profile is a set of estimates of the atmospheric pressure at specified altitudes above the Earth's surface. The requirements below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.5-1	a. Horizontal Cell Size	25 km	5 km
C40.3.5-2	b. Horizontal Reporting Interval	25 km	5 km
C40.3.5-3	c. Vertical Cell Size	1 km	0 km
	d. Vertical Reporting Interval		
C40.3.5-4	1. 0 - 2 km	1 km	0.25 km
C40.3.5-5	2. 2 - 5 km	1 km	0.5 km
C40.3.5-6	3. > 5 km	1 km	1 km
C40.3.5-7	e. Horizontal Coverage	Global	Global
C40.3.5-8	f. Vertical Coverage	0 - 30 km	0 - 30 km
C40.3.5-9	g. Measurement Range	10 - 1050 mb	10 - 1050 mb
	h. Measurement Accuracy		
C40.3.5-11	1. 0 - 10 km	5 % (TBR)	3 % (TBR)
C40.3.5-12	2. 10 - 30 km	10 % (TBR)	5 %
C40.3.5-13	i. Measurement Precision	4 mb	2 mb
C40.3.5-14	j. Mapping Uncertainty	7 km	1 km
C40.3.5-15	k. Swath Width	1700 km (TBR)	(TBD)

Total Water Content **TRD App D Section 40.3.6**

Total water content is defined as the water vapor, cloud liquid water, and cloud ice liquid equivalent in specified segments of a vertical column of the atmosphere. For this EDR vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported. The requirements below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.6-1	a. Horizontal Cell Size	20 km	10 km
C40.3.6-2	b. Horizontal Reporting Interval	20 km	10 km
C40.3.6-3	c. Vertical Cell Size (TBR)	3 km	1 km
C40.3.6-4	d. Vertical Reporting Interval	Vertical cell size	Vertical cell size
C40.3.6-5	e. Horizontal Coverage	Global	Global
C40.3.6-6	f. Vertical Coverage	0 - 20 km	0 - (TBD) km
C40.3.6-7	g. Measurement Range	0 - 200 kg/m² (TBR)	(TBD)
	h. Measurement Uncertainty		
C40.3.6-8	1. Point Measurement	2 kg/m^2	(TBD)
C40.3.6-9	2. Global Average	1 kg/m^2(TBR)	(TBD)
C40.3.6-10	i. Mapping Uncertainty	7 km	7 km
C40.3.6-11	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Cloud Base Height (TBR) **TRD App D Section 40.4.1**

Cloud base height is defined as the height above ground level where cloud bases occur. More precisely, for a cloud covered Earth location, cloud base height is the set of altitudes of the bases of the clouds that intersect the local vertical at this location. The reported heights are horizontal spatial averages over a cell, i.e., a square region of the Earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. As a threshold, only the height of the base of the lowest altitude cloud layer is required and objective is to report cloud base height for all distinct cloud layers.

Para. No.		Thresholds	Objectives
C40.4.1-1	a. Horizontal Cell Size	25 km	10 km
C40.4.1-2	b. Horizontal Reporting Interval	25 km	10 km
C40.4.1-3	c. Horizontal Coverage	Global	Global
	d. Vertical Cell Size	N/A	N/A
C40.4.1-4	e. Vertical Reporting Interval	Base of lowest cloud layer	Base of all distinct cloud layers
C40.4.1-5	f. Measurement Range	0 - 15 km	0 - 30 km
C40.4.1-6	g. Measurement Uncertainty	2 km	0.25 km
C40.4.1-7	h. Mapping Uncertainty	5 km	1 km
C40.4.1-8	i. Swath Width	1700 km (TBR)	3000 km (TBR)

Cloud Ice Water Path **TRD App D Section 40.4.4**

Cloud ice water path is defined as the equivalent amount of water within cloud ice particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud ice water path must be reported.

Para. No.		Thresholds	Objectives
C40.4.4-1	a. Horizontal Cell Size	50 km	10 km
C40.4.4-2	b. Horizontal Reporting Interval	50 km	10 km
C40.4.4-3	c. Vertical Cell Size	N/A (Total Column)	0.3 km
C40.4.4-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
C40.4.4-5	e. Horizontal Coverage	Global	Global
C40.4.4-6	f. Vertical Coverage	N/A (Total Column)	0 - 20 km
C40.4.4-7	g. Measurement Range	0 - 2.6 kg/m^2 (TBR)	0 - 10 kg/m^2
C40.4.4-8	h. Measurement Accuracy	10 % or 5 g/m^2 (TBR)	5 %
C40.4.4-9	i. Measurement Precision	5 %	2 %
C40.4.4-10	j. Long Term Stability	2 %	1 %
C40.4.4-11	k. Mapping Uncertainty	4 km	1 km
C40.4.4-12	l. Swath Width	1700 km (TBR)	3000 km (TBR)

Cloud Liquid Water **TRD App D Section 40.4.5**

Cloud liquid water is defined as the equivalent amount of water within cloud particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported.

Para. No.		Thresholds	Objectives
C40.4.5-1	a. Horizontal Cell Size	20 km	5 km
C40.4.5-2	b. Horizontal Reporting Interval	20 km	5 km
C40.4.5-3	c. Vertical Cell Size	N/A (Total Column)	0.3 km
C40.4.5-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
C40.4.5-5	e. Horizontal Coverage	Global	Global
C40.4.5-6	f. Vertical Coverage	N/A (Total Column)	0 - 30 km
C40.4.5-7	g. Measurement Range	0 - 5 kg/m^2	(TBD)
	h. Measurement Uncertainty		
C40.4.5-8	1. Over ocean	0.25 kg/m^2	0.01 kg/m^2
C40.4.5-9	2. Over land	0.5 kg/m^2	0.01 kg/m^2
C40.4.5-10	i. Mapping Uncertainty	7 km	1 km
C40.4.5-11	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Snow Cover/Depth **TRD App D Section 40.6.3**

Horizontal and vertical extent of snow cover. As a threshold, only the fraction of snow cover in the specified horizontal cell is required, regardless of depth. As an objective, fraction of snow cover for snow having a specified minimum depth is required in the specified horizontal cell for a set of specified minimum depths.

Para. No.		Thresholds	Objectives
C40.6.3-1	a. Horizontal Cell Size	12.5 km	1 km
C40.6.3-2	Deleted		
C40.6.3-3	b. Horizontal Reporting Interval	12.5 km	1 km
C40.6.3-4	c. Snow Depth Ranges	> 0 cm (Any Snow Thickness)	> 8 cm, > 15 cm, > 30 cm, >51 cm, >76 cm
C40.6.3-5	d. Horizontal Coverage	Land	Land & Ice
C40.6.3-6	e. Vertical Coverage	> 0 cm	0 - 1 m
C40.6.3-7	f. Measurement Range	0 – 100%	0 - 1 per snow depth category
C40.6.3-8	g. Measurement Uncertainty	20 % (snow/no snow)	10 % for snow depth
C40.6.3-9	Deleted		
C40.6.3-10	h. Mapping Uncertainty	3 km	1 km
C40.6.3-11	Deleted		
C40.6.3-12	k. Swath Width	1700 km (TBR)	3000 km (TBR)

Fresh Water Ice **TRD App D Section 40.7.2**

Fresh water ice concentration is defined as the fraction of a given area of fresh water that is covered by ice, quantized to the nearest one tenth. Ice edge boundary is the contour separating fresh water from fresh water ice. The error in ice edge boundary location is defined as the distance between a measured boundary point and the nearest point on the true ice edge boundary. The measurement uncertainty requirement on ice edge boundary limits this error.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.7.2-1	1. Nadir	20 km (TBR)	(TBD)
C40.7.2-2	2. Worst case	20 km (TBR)	(TBD) 0.65 km
C40.7.2-3	b. Horizontal Reporting Interval	20 km	(TBD)
C40.7.2-4	c. Horizontal Coverage	Global: Fresh Water	Global: Fresh Water
C40.7.2-5	d. Measurement Range	1/10 to 10/10 concentration	0/10 to 10/10 concentration
C40.7.2-6	e. Measurement Uncertainty		
C40.7.2-7	1. Ice Edge Boundary	10 km	5 km
C40.7.2-8	2. Ice Concentration	20 % or 1/10	10 %
C40.7.2-9	f. Mapping Uncertainty	3 km	1 km
C40.7.2-10	g. Swath Width	1700 km (TBR)	(TBD)

Ice Surface Temperature **TRD App D Section 40.7.3**

This EDR is required under clear and cloudy conditions. As a threshold, the temperature of the surface of ice over land or water is required. The objective is to measure the atmospheric temperature 2 m above the surface of the ice.

Para. No.		Thresholds	Objectives
C40.7.3-1	a. Horizontal Cell Size	30 km	10 km
C40.7.3-2	b. Horizontal Reporting Interval	30 km	10 km
C40.7.3-3	c. Horizontal Coverage	Ice-covered land/water	Ice-covered land/water
C40.7.3-4	d. Measurement Range	213-275 K (ice surface)	213-293 K (2m above ice)
C40.7.3-5	e. Measurement Uncertainty	1 K	(TBD)
C40.7.3-6	f. Mapping Uncertainty	3 km	1 km
C40.7.3-7	g. Swath Width	1700 km (TBR)	(TBD)

Sea Ice Age and Sea Ice Edge Motion **TRD App D Section 40.7.8**

The requirements below apply under both clear and cloudy conditions. Sea ice age is defined as the time that has passed since the formation of the surface layer of an ice covered region of the ocean. The content of the sea ice age EDR is the typing of areas of sea ice by age. Sea ice motion is defined as the displacement of a sea ice edge. Definitions of the Ice Age Classes are included below. Ice concentration is defined as the fraction of a given area of sea or water covered by ice. An ice edge is defined as the boundary between ice-covered sea water (ice concentration > 0.1) and sea water not covered by ice (ice concentration ≤ 0.1).

Para. No.		Thresholds	Objectives
C40.7.8-1	a. Horizontal Cell Size	20 km	0.1 km
C40.7.8-2	b. Horizontal Reporting Interval	20 km	0.1 km
C40.7.8-3	c. Horizontal Coverage	Oceans	Oceans
	d. Measurement Range		
C40.7.8-4	1. Ice Age Classes	First Year, Multi-year	New, Young, First Year, and Old
C40.7.8-5	2. Ice Motion	0-50 km/day	0 - 50 km/day
C40.7.8-6	e. Probability of Correct Typing (Ice Age)	70 %	90 %
C40.7.8-7	f. Measurement Uncertainty (Ice motion)	1 km/day	0.1 km/day
C40.7.8-8	g. Mapping Uncertainty	3 km	1 km
C40.7.8-9	h. Swath Width	1700 km	3000 km (TBR)
C40.7.8-10	i. Measurement Uncertainty (Ice Edge Location)	(TBD)	(TBD)
C40.7.8-11	j. Measurement Range (Concentration)	0.1–1 (0.1 increments)	0–1 (0.1 increments)
C40.7.8-12	k. Measurement Uncertainty (Concentration)	0.1 or 20%	10%

The following definitions from WMO Sea-Ice Nomenclature and the Handbook for Sea Ice Analysis and Forecasting apply to the EDR table above:

Sea Ice:

Any form of ice found at sea which has originated from the freezing of sea water.

New Ice

A general term for recently formed ice which includes frazil ice, grease ice, slush and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definitive form only while they are afloat.

Young Ice

Ice in the transition stage between nilas and first-year ice, 10-30 cm in thickness.

First Year Ice

Sea ice of not more than one winter's growth, developing from young ice; thickness 30 cm - 2 m.

Multi-year Ice

Old ice up to 3 m or more thick which has survived at least two summers' melt.

Old Ice

Sea ice which has survived only one summer's melt; typical thickness up to 3 m and sometimes more.

Supporting definitions:

Anchor Ice:

Submerged ice attached or anchored to the ocean bottom, irrespective of the nature of its formation.

Frazil Ice:

Represents the first stage in the freezing process. Fine spicules or plates of ice, suspended in water.

Grease Ice:

A later stage of freezing than frazil ice when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matt appearance.

Slush:

Snow which is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snowfall.

Shuga:

An accumulation of spongy white ice lumps, a few centimeters across; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface.

Nilas:

A thin elastic crust of ice, easily bending on waves and swell and under pressure, thrusting in a pattern of interlocking 'fingers' (finger rafting). Has a matt surface and is up to 10 cm in thickness. May be subdivided into dark nilas and light nilas."

Surface Wind Stress (TBR) **TRD App D Section 40.7.10**

The requirements below apply under both clear and cloudy conditions. Surface wind stress is defined as the magnitude of the frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves. It is a derived EDR from the Sea Surface Winds (SSW) and drag coefficient.

Para. No.		Thresholds	Objectives
C40.7.10-1	a. Horizontal Cell Size	50 km	20 km
C40.7.10-2	b. Horizontal Reporting Interval	50 km	20 km
C40.7.10-3	c. Horizontal Coverage	Oceans	Oceans
C40.7.10-4	d. Measurement Range	Consistent with SSW	Consistent with SSW
C40.7.10-5	e. Measurement Accuracy	Consistent with SSW	Consistent with SSW
C40.7.10-6	f. Measurement Precision	Consistent with SSW	Consistent with SSW
C40.7.10-7	g. Mapping Uncertainty	7 km	1 km (TBR)
C40.7.10-8	i. Swath Width	1700 km	3000 km (TBR)

Land Surface Temperature **TRD App D Section 40.6.1**

Land surface temperature (LST) is defined as the aggregate temperature of all objects comprising the land surface.

Para. No.		Thresholds	Objectives
C40.6.1-1	a. Horizontal Cell Size	50 km	1 km
C40.6.1-2	b. Horizontal Reporting Interval	50 km	1 km
C40.6.1-3	c. Horizontal Coverage	Land	Land
C40.6.1-4	d. Measurement Range	213 K - 343 K	213 K - 343 K
C40.6.1-5	e. Measurement Accuracy	2.5 K	1 K
C40.6.1-6	f. Measurement Precision	0.5 K	0.025 K
C40.6.1-7	g. Mapping Uncertainty	5 km	1 km
C40.6.1-8	h. Swath Width	1700 km	3000 km (TBR)

Vegetation/Surface Type **TRD App D Section 40.6.4**

Vegetation/surface type is defined as the predominant vegetation type in a given area. Estimation of the percentage of vegetation cover per type in each cell is an objective. The requirements below apply in both clear and cloudy conditions. The following table defines the 17 Vegetation/Surface types required from NPOESS.

Land Cover Class	**Definition**
1. Evergreen Needleleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Almost all trees remain green all year. Canopy is never without green foliage.
2. Deciduous Needleleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Consists of seasonal needleleaf tree communities with an annual cycle of leaf-on and leaf-off periods.
3. Evergreen Broadleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Almost all trees and shrubs remain green all year. Canopy is never without green foliage.
4. Deciduous Broadleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Consists of broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.
5. Mixed Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Consists of tree communities with interspersed mixtures or mosaics of the other four forest types. None of the forest types exceeds 60% of landscape.
6. Closed Shrublands	Lands with woody vegetation less than 2 meters tall and with shrub canopy cover >60%. The shrub foliage can be either evergreen or deciduous.
7. Open Shrublands	Lands with woody vegetation less than 2 meters tall and with shrub canopy cover between 10-60%. The shrub foliage can be either evergreen or deciduous.
8. Woody Savannas	Lands with herbaceous and other understory systems, and with forest canopy cover between 30-60%. The forest cover height exceeds 2 meters.
9. Savannas	Lands with herbaceous and other understory systems, and with forest canopy cover between 10-30%. The forest cover height exceeds 2 meters.
10. Grasslands	Lands with herbaceous types of cover. Tree and shrub cover is less than 10%.
11. Permanent Wetlands	Lands with a permanent mixture of water and herbaceous or woody vegetation. The vegetation can be present in either salt, brackish, or fresh water.

12. Croplands	Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems). Note than perennial woody crops will be classified as the appropriate forest or shrubland cover type.
13. Urban and Built-Up	Land covered by buildings and other man-made structures.
14. Cropland/Natural Vegetation Mosaics	Lands with a mosaic of croplands, forests, shrubland, and grasslands in which no one component comprises more than 60% of the landscape.
15. Snow and Ice	Lands under snow/ice cover.
16. Barren	Lands with exposed soil, sand, rocks, or snow and never has more than 10% vegetated cover during any time of the year.
17. Water Bodies	Oceans, seas, lakes, reservoirs, and rivers. Can be either fresh or salt-water bodies.

Table 3.2.1.1.1.1

SRDC3.2.1.1.1.1-7 The CMIS instrument shall be capable of discriminating the following aggregated types:

CMIS Classification	**Land Cover Class**
Dense Vegetation	1-5
Moderate Vegetation	6-9
Sparse Vegetation and Cropland	10,12,14
Barren	16
Urban	13
Snow and Ice	15
Water Bodies and Wetlands	11,17
Not Classified	N/A

Table 3.2.1.1.1.1-1

Para. No.		Thresholds	Objectives
C40.6.4-1	a. Horizontal Cell Size	20 km	0.25 km
C40.6.4-2	Not Used	N/A	N/A
C40.6.4-3	b. Horizontal Reporting Interval	20 km	0.25 km
C40.6.4-4	c. Horizontal Coverage	Land	Land
C40.6.4-5	Not Used	N/A	N/A
	d. Measurement Range		
C40.6.4-6	1. Vegetation/surface type	8 types in CMIS Classification (Table 3.2.1.1.1.1-1)	17 types (NPOESS requirement)
C40.6.4-7	2. Vegetation cover	N/A	0 - 100 %
C40.6.4-8	e. Measurement Accuracy (veg. cover)	N/A	2 %
C40.6.4-9	f. Measurement Precision (veg. cover)	N/A	0.1 %
C40.6.4-10	g. Correct Typing Probability (vegetation /surface type)	70 %	(TBD)
C40.6.4-11	h. Mapping Uncertainty	5 km	1 km
C40.6.4-12	i. Swath Width	1700 km (TBR)	3000 km (TBR)

Secondary EDRs

Deleted.

SRDC3.2.1.1.1.1-8
Deleted.

3.2.1.1.1.2.1 Requirements Prioritization

Guidance on the relative prioritization of EDRs with respect to each other and with respect to accommodation requirements addressed elsewhere in this SRD (for example, but not limited to, Section 3.2.4), are provided in the following two sections.

3.2.1.1.1.2.1.1 EDR Prioritization

EDRs are partitioned into two sets of categories. Categories I, II, and III address the ranking of threshold requirements. Categories A and B address the ranking of objectives.

The EDR threshold prioritization categories are defined as follows:

- Category I – Trades addressing performance below threshold generally not of interest.
- Category II – Trades addressing performance below threshold are of interest only for thresholds that are significant design drivers or when significant benefit (i.e., reduced cost, improved performance in other EDRs, improved spacecraft accommodation, etc.) is provided to the Government.
- Category III – Trades addressing performance below threshold are generally of interest especially when the thresholds are significant design drivers or significant benefit (i.e., reduced cost, improved performance in other EDRs, improved spacecraft accommodation, etc.) is provided to the Government. In general, thresholds should not be allowed to drive sensor design.

The EDR objective prioritization categories are defined as follows:

- Category A - Value to Government if thresholds are exceeded and/or objectives are approached.
- Category B - Value to Government if thresholds are exceeded and/or objectives are approached; however, in general, approaching objectives should not be allowed to significantly drive design.

The CMIS EDRs are prioritized as follows:

	Threshold	Objective
• Atmospheric Vertical Moisture Profile (Surface to 600mb Measurement Uncertainty)	I	A
• Sea Surface Winds (Speed)	I	A
• Soil Moisture	I	A
• Atmospheric Vertical Moisture Profile (Remaining Attributes)	II	A

• Atmospheric Vertical Temperature Profile	II	A
• Cloud Ice Water Path	II	A
• Cloud Liquid Water	II	A
• Ice Surface Temperature	II	B
• Land Surface Temperature	II	B
• Precipitation	II	A
• Precipitable Water	II	A
• Sea Ice Age and Sea Ice Edge Motion	II	B
• Sea Surface Temperature	II	A
• Sea Surface Winds (Direction)	II	A
• Total Water Content	II	A
• Cloud Base Height	III	B
• Fresh Water Ice	III	B
• Imagery	III	B
• Pressure Profile	III	B
• Snow Cover	III	B
• Snow Depth	III	A
• Surface Wind Stress	III	B
• Vegetation/ Surface Type	III	B

The above EDRs are listed alphabetically within each threshold category, and no prioritization is implied by the ordering within these categories.

3.2.1.1.1.2.1.2 Integrated Requirements Prioritization

CMIS EDR and accommodation requirements are prioritized as follows, in descending order of priority:

- Category I EDRs
- Category II EDRs/Cost
- Volume
- Category A EDRs/Mass
- Power
- Category III EDRs
- Category B EDRs
- Data Rate

3.2.1.1.1.2.2 Databases and Model Computation (TBR)

SRDC3.2.1.1.1.2.2-1
The contractor shall include in his requirements flowdown analysis uncertainties in data from any databases that are relied upon in generating EDRs.

SRDC3.2.1.1.1.2.2-2
If the contractor determines that these uncertainties prevent a threshold requirement from being met, if reliance on the database is deemed necessary by the contractor, and if the database varies in time, e.g., is updated in near real time, and is not under the control of the contractor, then the contractor shall so notify the government and the government will determine the appropriate remedial action.

SRDC3.2.1.1.1.2.2-3
If a fixed database, e.g., one addressing terrain, is needed, and existing databases are not adequate to allow thresholds to be met, the contractor shall generate a new database or partial database having the characteristics necessary to demonstrate that EDR thresholds can be met.

SRDC3.2.1.1.1.2.2-4
The contractor shall identify and quantify any EDR performance degradation resulting from the lack of availability of any database or other ancillary data.

3.2.1.1.1.3 Horizontal Cell Size (HCS) and Horizontal Reporting Interval (HRI)

The Horizontal Cell Size (HCS) attribute of an EDR is intended to represent the spatial extent over which an estimate of that EDR is produced by the EDR algorithm. The horizontal cell is also the area over which the retrieved EDR estimate is compared to the "true value" for that EDR in order to determine the Measurement Error (ME) performance (ME is specified by Measurement Accuracy, Precision and Uncertainty). The "true value" of the EDR within the Horizontal Cell is determined from a uniform average of the "true value" over the cell. The HCS is only defined at the data product or EDR level. It is not a sensor parameter.

The Horizontal Reporting Interval (HRI) requirement is equal to the HCS requirement for each of the CMIS EDRs.

SRDC3.2.1.1.1.3-1
The horizontal cell (or cells) shall be square with each side of length equal to the HCS value for each EDR.

SRDC3.2.1.1.1.3-2
Each CMIS contractor shall describe what they consider to be the best value approach for the reporting grid of Horizontal Cells consistent with the requirements on HCS and HRI.

SRDC3.2.1.1.1.3-3
Each CMIS contractor shall quantify all performance impacts associated with their choice of reporting grid by including all associated error sources in their EDR error budget tables.

SRDC3.2.1.1.1.3-4
Each CMIS contractor shall quantify all geometric and radiometric approximations associated with each data product level (RDR to TDR, TDR to SDR, SDR to EDR).

3.2.1.1.1.4 Horizontal Spatial Resolution (HSR) reporting requirements

In order for the Government to more fully understand and evaluate the operation of CMIS as an imaging radiometer, specific information about the CMIS HSR is requested from the CMIS contractors by the following requirements.

In this section (3.2.1.1.1.4), the HSR in the along-scan and cross-scan directions is determined by the –3 dB contour of the end-to-end CMIS sensor Modulation Transfer Function (MTF) (from the antenna input to the RDR level), projected on the surface of the Earth and weighted over the CMIS channel pass-band.

SRDC3.2.1.1.1.4-1
For each CMIS channel, the contractor shall report the HSR, in the along-scan and cross-scan directions.

SRDC3.2.1.1.1.4-2
If there is more than 5% variation in the HSR for any CMIS channel over CMIS scan, the contractor shall report the minimum, maximum, and average values in the along-scan and cross-scan directions for that channel.

SRDC3.2.1.1.1.4-3
The CMIS contractor shall provide the details of the derivation of the HSR values required by SRDC3.2.1.1.1.3-1 and -2, including all assumptions made.

SRDC3.2.1.1.1.4-4
The CMIS contractor shall provide a detailed description of the 90% energy contour of the projected system Point Spread Function (PSF) for each CMIS channel, at the center of scan, referenced by two orthogonal directions corresponding to the along-scan and cross-scan.

3.2.1.1.2 Sensor Data Record (SDR) Requirements (TBR)

3.2.1.1.2.1 Definition

The Sensor Data Record (SDR) is defined in Appendix A.

3.2.1.1.2.2 Requirements

SRDC3.2.1.1.2.2-1
The CMIS vendor shall provide to the Interface Data Processor Segment (IDPS) the algorithms and sensor data necessary to process TDR data into SDR data.

SRDC3.2.1.1.2.2-2
The operational SDR data shall contain as a minimum the following data and information:

- Brightness Temperature data for each channel
- Geolocation data for each sample: geodetic latitude and longitude
- Spacecraft ID tag
- CMIS sensor ID or serial number
- Flight software version number
- Orbit number
- Beginning Julian day and time tag
- Ending Julian day and time tag
- Ascending Node Julian day and time tag
- Time tag information - beginning of scan time
- Scan index

SRDC3.2.1.1.2.2-3
The CMIS contractor shall recommend additional information and data to be included in the SDR.

3.2.1.1.3 Temperature Data Record (TDR) Requirements (TBR)

3.2.1.1.3.1 Definition

The Temperature Data Record (TDR) is defined in Appendix A.

3.2.1.1.3.2 Requirements

SRDC3.2.1.1.3.2-1
The CMIS vendor shall provide to the IDPS the algorithms and sensor data necessary to process RDR data into TDR data.

SRDC3.2.1.1.3.2-2
The operational TDR data shall contain as a minimum the following data and information:

- Antenna Temperature data for each channel and sample
- Sensor health and status data: limited to that necessary to assess performance and compute Sensitivity
- Sensor calibration data
- Spacecraft ID tag
- CMIS sensor ID or serial number
- Flight software version number
- Orbit number
- Beginning Julian day and time tag
- Ending Julian day and time tag
- Ascending Node Julian day and time tag
- Satellite Ephemeris data: sufficient to geolocate each data sample

Time tag information - beginning of scan time
Scan index

SRDC3.2.1.1.3.2-3
The CMIS contractor shall recommend additional information and data to be included in the TDR.

3.2.1.1.4 Raw Data Record (RDR) Requirements (TBR)

3.2.1.1.4.1 Definition

The RDR is defined in Appendix A.
Because RDRs are processed into EDRs, RDRs are considered to have met their requirements when they are of an appropriate format and quality to be adequately processed into their associated EDRs.

3.2.1.1.4.2 Requirements

SRDC3.2.1.1.4.2-1
The RDR shall, as a minimum, consist of the following information:

Raw data counts for each CMIS channel
Spacecraft ID tag
CMIS sensor ID or serial number
Flight software version number
Orbit number
Beginning Julian day and time tag
Ending Julian day and time tag
Ascending Node Julian day and time tag
Satellite Ephemeris data: sufficient to geolocate each data sample
Time tag information - beginning of scan time
Scan index number
Sensor calibration data
Sensor health and status data: limited to that necessary to assess performance and compute Sensitivity
CMIS mounting offset angles - needed for geolocation

SRDC3.2.1.1.4.2-2
The CMIS contractor shall recommend additional information and data to be included in the RDR.

3.2.1.1.5 Algorithms

SRDC3.2.1.1.5-1
EDR scientific algorithms shall be provided by the CMIS contractor.

SRDC3.2.1.1.5-2
The CMIS scientific algorithms shall provide EDRs which satisfy the NPOESS requirements as specified in Section 3.2.1.1.1.1. Scientific algorithms may also be recommended by the government's Operational Algorithm Teams (OATs).

SRDC3.2.1.1.5-3
The contractor shall identify the use of all non-CMIS data required for algorithm processing.

SRDC3.2.1.1.5-4
The Contractor shall provide an Algorithm Theoretical Basis Document (ATBD) for the assigned set of Primary EDRs. ATBDs provide the physical theory and assumptions behind the EDRs, as well as the mathematical procedures required to produce the RDRs, convert the RDRs into the SDRs, and convert the SDRs into the EDRs. The ATBD should discuss limitations on the approach, accuracy considerations, additional information required for measurement processing (mandatory and desirable), and alternative processing approaches required under alternative measurement situations (e.g., daytime and nighttime observations).

SRDC3.2.1.1.5-5
The Contractor shall provide research grade source code implementing the algorithm(s) described in the ATBD that address the primary EDRs. The research grade code should include all processes, other than input/output, needed to: convert RDRs into SDRs; convert SDRs into EDRs; use all mandatory outside data; use any optional outside data, if available; select alternative processing algorithms based on the data available; provide continuing calibration validation; and any other similar processing tasks required to satisfy allocated EDR quality and availability requirements. The scientific algorithms provided by the contractor may be adopted or adapted from existing algorithms, or developed, as needed.

3.2.1.1.5.1 Convertibility to Operational Algorithms

The government considers the SDR and EDR algorithms adopted, adapted, or developed by the CMIS contractor to be scientific, rather than operational, algorithms. The CMIS contractor is not responsible for identifying or developing operational SDR and EDR algorithms for the CMIS. (Any operational algorithms necessary for the generation of RDRs will ultimately be the responsibility of the CMIS contractor, and the operational software implementing these algorithms will be part of the required flight software. This statement applies to the post-downselect phase of the CMIS program.)

SRDC3.2.1.1.5.1-1
The scientific SDR and EDR algorithms delivered by the CMIS contractor shall be convertible into operational software that is compatible with a 20 minute maximum processing time at either the DoD Centrals or DoD field terminals for the conversion of all pertinent RDRs into all required EDRs for the site or terminal, including those based wholly or in part on data from other sensor suites. The intent of this requirement is to preclude algorithms that are so computationally intensive that any foreseeable

implementation would stress or exceed the time available for delivery of EDRs in an operational environment.

SRDC3.2.1.1.5.1-2
The means by which the contractor shall validate the requirement that scientific algorithms be convertible to operational software, subject to the processing time constraint specified in this Section, is (**TBD**).

SRDC3.2.1.1.5.1-3
The availability of any inputs required, from databases or non-CMIS data sources, to generate EDRs shall be sufficient to allow EDRs to be generated at the DoD Centrals and DoD field terminals within the time constraint specified in this Section.

3.2.1.1.5.2 Performance Requirements

SRDC3.2.1.1.5.2-1
The performance of the CMIS science algorithms delivered by the CMIS contractor shall meet EDR thresholds.

SRDC3.2.1.1.5.2-2
The performance of the CMIS science algorithms shall be no worse than the performance of algorithms utilized for current operational data products for these EDRs, if such operational products exist (TBR).

3.2.1.2 CMIS Channels

3.2.1.2.1 Definition

A sensor channel is determined by the pass-band frequencies, bandwidths and polarization characteristics of the measurements.

3.2.1.2.2 Number of Channels

SRDC3.2.1.2.2-1
The number of channels shall be sufficient to satisfy the EDR requirements assigned to CMIS.

3.2.1.3 CMIS Frequency Bands

3.2.1.3.1 Use Of Allocated Frequency Bands

To reduce the possibility of interference from other communication/radio services, the CMIS should use frequency bands which correspond to the international allocations for Earth Exploration-Satellite and are reserved for such usage.

SRDC3.2.1.3.1-1
Utilization of other frequency bands shall be justified by analysis(es) showing significant performance and/or cost advantages.

SRDC3.2.1.3.1-2
An attempt shall be made to utilize frequency bands having the minimum possible risk of interference from other allocated radio services.

SRDC3.2.1.3.1-3
All frequency bands utilized by the CMIS shall be approved by the government. Exceptions to this are noted in Section 3.2.1.3.2.
The frequencies listed in Table 3.2.1.3.1 are based on current (time of writing) NTIA allocations and are subject to change. The contractor should verify, in conjunction with the Government, the accuracy of this table and the applicability of the frequency allocations for the time period when CMIS is planned to be operational.

TABLE 3.2.1.3.1 FREQUENCY ALLOCATIONS FOR REMOTE SENSING

This table contains a summary of frequency band allocations involving the Earth Exploration-Satellite service (passive sensing).

Frequency band (GHz)		Allocation	Notes:
1.37	1.40	Secondary	
1.4	1.427	Exclusive	
2.69	2.70	Exclusive with exceptions	1. Some pre-existing radio services (prior to 1/1/1985) protected as primary users within Region 1
2.64	2.655	Secondary	
4.95	4.99	Secondary	
6.8		Not allocated for passive sensing	
10.6	10.7	Shared	2. The portion 10.6-10.68 GHz is exclusive passive in U.S. only; internationally, this band is shared with Fixed, and Mobile services, usually with power restrictions. Aeronautical service within this band discouraged.
15.20	15.35	Secondary	
15.35	15.4	Exclusive	3. Some fixed and mobile services provided for, internationally, on a secondary basis.
18.6	18.8	Shared	4. The band 18.6 to 18.8 GHz is allocated to passive services as a shared user in Region 2, and secondary user in Regions 1 and 3, shared with Fixed and Fixed Satellite to Earth. Non-government primary allocation to Fixed. Users encouraged to limit, as much as practical, their power flux density at the Earth's surface.
21.20	21.40	Exclusive	
22.21	22.5	Shared	5. The band 22.21 - 22.5 GHz is shared with fixed, and mobile services. Administrators are encouraged to take all practical steps to protect the radio astronomy service. However, passive services can not impose constraints upon the fixed or mobile services except for aeronautical mobile.
23.60	24.0	Exclusive	
31.3	31.5	Exclusive	
31.5	31.8	Shared	6. The band 31.5 - 31.8 GHz is allocated exclusively for passive sensing in the U.S. However, 31.5 - 31.8 GHz is shared with Fixed and Mobile in Regions 1 and 3. Within Regions 1 and 3, administrators are encouraged to limit frequency assignments that would cause harmful interference to passive sensing.
36.0	37.0	Shared	7. The band 36.0 - 37.0 GHz is shared with Fixed and Mobile

Frequency band (GHz)		Allocation	Notes:
			services. Administrators are encouraged to take all practical steps to protect the spectral line observations of the radio astronomy service in the band 36.43 - 36.5 GHz.
50.2	50.4	Shared	
50.4	51.4	Not allocated for passive sensing	8. The band 50.4 - 51.4 GHz is allocated to Fixed, Fixed-Satellite (Earth-to-Space), Mobile, and Mobile Satellite (Earth-to-Space).
51.4	54.25	Exclusive	
54.25	58.0	Shared	9. The band 54.25 - 58.0 GHz is allocated for passive sensing, shared with Fixed, Intersatellite, and Mobile (including aeronautical mobile). In a few countries this band is allocated to Radiolocation on a primary basis.
58.2	59.0	Exclusive	
59.0	64.0	Not allocated for passive sensing	10. The band 59.0 - 64.0 GHz is allocated for Intersatellite communications. (This band may be re-allocated.)
64.0	65.0	Exclusive	
65.0	66.0	Shared	11. The band 65.0 - 66.0 GHz is allocated for passive sensing, to be shared with the Fixed and Mobile services.
86.0	92.0	Exclusive	
92.0	95.0	Not allocated for passive sensing	12. The band 92.0 - 95.0 GHz is allocated to Fixed, Fixed-Satellite (Earth-to-Space), Mobile, and Radiolocation
100.0	102.0	Shared	13. The band 100.0 - 102.0 GHz is allocated passive, shared with Fixed, and Mobile.
105.0	116.0	Exclusive	
116.0	126.0	Shared	14. The band 116.0 - 126.0 GHz is allocated to passive, shared with Fixed, Intersatellite, and Mobile.
150.0	151.0	Shared	15. The bands 150.0 - 151.0 GHz and 174.5 - 176.5 GHz are allocated primary to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
164.0	168.0	Exclusive	
174.5	176.5	Shared	15. The bands 150.0 - 151.0 GHz and 174.5 - 176.5 GHz are allocated primary to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
182.0	185.0	Exclusive	
200.0	202.0	Shared	16. The band 200.0 - 202.0 GHz is allocated to passive, shared with Fixed, and Mobile.
217.0	231.0	Exclusive	
235.0	238.0	Shared	17. The band 235.0 - 238.0 GHz is allocated to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
250.0	252.0	Exclusive	

Note: There are no allocations above 300 GHz.

SRDC3.2.1.3.1-4

The contractor shall utilize the most up-to-date information as it becomes available. (Reference Document: Manual of Regulations and Procedures for Federal Radio Frequency Management, Sept. 1995.)

Note that the specific frequencies and polarizations required by the CMIS are determined by the CMIS contractor as part of their design analysis and subject to the constraints discussed in this section.

SRDC3.2.1.3.1-5
The final choices for the CMIS frequency bands shall depend not only on the frequency allocations, but on phenomenological and radiometric considerations, and the necessity of meeting the EDR performance requirements in Section 3.2.1.1.1.1.

3.2.1.3.2 CMIS Frequency Bands: Exceptions

This section lists specific exceptions to the use of exclusive allocations discussed in Section 3.2.1.3.1. The CMIS contractor is not required to make use of these exceptions.

3.2.1.3.2.1 The 183 GHz Water Vapor Band

Due to its heritage and recognized utility for water vapor remote sensing, the CMIS contractor is allowed to utilize center frequencies and bandwidths that lie within the frequency band 170.0 to 195.0 GHz. A detailed justification for use of a non-protected band is not required in this case.

SRDC3.2.1.3.2.1-1 Deleted.

3.2.1.3.2.2 Additional Exceptions

Additional Exceptions are (**TBD**).

3.2.1.4 Sensitivity

3.2.1.4.1 Definition

The end-to-end radiometric sensitivity is the change in Brightness Temperature of the incident radiation at the collecting aperture required to change the mean value of the measured Brightness Temperature by one standard deviation at the digitized output of the radiometer when sampled at the rate determined by the pre-sampling filter. This is denoted as ΔT_{rms} and also referred to as Noise-Equivalent Temperature Difference (NEDT). Units are Kelvin.

3.2.1.4.2 Requirement

SRDC3.2.1.4.2-1
The ΔT_{rms} value shall be consistent with meeting all of the CMIS EDR requirements and the requirements for radiometric accuracy.

SRDC3.2.1.4.2-2
An error analysis/budget for the CMIS pre-launch and on-orbit NEDT, which includes all relevant noise sources, shall be provided to the Government.

SRDC3.2.1.4.2-3
The sensitivity of each CMIS channel shall be measured over the range of scene Brightness Temperatures of (TBD) to (TBD).

3.2.1.5 Radiometric Measurement Accuracy

3.2.1.5.1 Absolute Radiometric Accuracy

3.2.1.5.1.1 Definition

The absolute radiometric accuracy, for each CMIS channel, is defined as the difference between the brightness temperature values as measured by the CMIS and the true measured emissive temperature of the standard target. The conditions under which these measurements are performed are (TBD). The units are Kelvin.

SRDC3.2.1.5.1.1-1
The absolute accuracy of each CMIS channel shall be determined by its ability to correctly measure the brightness temperature of an external calibration target having an emissivity consistent with the calibration target requirements in Section 3.2.1.10 over the temperature range of (TBD) K.

3.2.1.5.1.2 Requirement

SRDC3.2.1.5.1.2-1
The absolute radiometric measurement accuracy shall be consistent with meeting the CMIS EDR requirements and provide, at the SDR level, measured brightness temperatures accurate to within the performance specified in Table 3.2.1.5.1.2 over the CMIS dynamic range (see Section 3.2.1.6.3).

SRDC3.2.1.5.1.2-2
The CMIS calibration shall be traceable to a (TBD) calibration standard.

Table 3.2.1.5.1.2 Radiometric Measurement Accuracy Requirements for Each Channel.

(TBD)

3.2.1.5.2 Inter-channel Accuracy

SRDC3.2.1.5.2-1
The relative (inter-channel) and absolute measurement accuracy of relevant channels shall be maintained for the retrieval of (TBD) EDRs..

3.2.1.5.2.1 Definition

The inter-channel accuracy is defined as the difference of the brightness temperature measurements of any two relevant CMIS channels, when both channels are viewing the same standard calibration target, under identical conditions.

3.2.1.5.2.2 Requirement

SRDC3.2.1.5.2.2-1
The inter-channel accuracy requirements for related sounding and surface-sensing channels shall be as specified in Table 3.2.1.5.2.2.

SRDC3.2.1.5.2.2-2
The requirements in Table 3.2.1.5.2.2 shall be met in addition to the overall accuracy requirements listed in Section 3.2.1.5.1.

Table 3.2.1.5.2.2 CMIS Inter-channel Accuracy Requirements

(TBD)

3.2.1.5.3 Polarimetric Channels

3.2.1.5.3.1 Definition

A polarimetric channel is defined as a CMIS channel that is intended to contribute either directly or indirectly to measurement(s) of the incident Stokes' field beyond the first two Stokes' parameters (I and Q), or equivalently, beyond the first two modified Stokes' parameters (T_v and T_h) (see Figure 3.2.1.9.1.1-1).

Note: The above definition may be interpreted to apply to any or all channels used for direct or indirect measurements of the Third and/or Fourth Stokes' parameters, linearly-polarized channels intentionally offset (in azimuth) from the vertical (Tv) or horizontal (Th) polarization direction, and ellipically-polarized channels intended for measurements of the Fourth Stokes' parameter. Typically, some or all CMIS channels used to derive Sea Surface Wind Direction are considered to be polarimeteric.

The four Stokes parameters in the Earth's natural polarization basis are defined in terms of the upwelling vertically- and horizontally-polarized components of the electric fields incident on the CMIS antenna(s):

$$\mathbf{T} = [\langle E_V E_V^* \rangle,\ \langle E_h E_h^* \rangle,\ 2\mathrm{Re}\langle E_V E_h^* \rangle,\ 2\mathrm{Im}\langle E_V E_h^* \rangle]^T$$
$$= [T_V, T_h, T_U, T_4]^T$$

where: E_V and E_h are the vertically- and horizontally-polarized time-varying electric fields of the incident radiation. Orientation of the above electric field vectors is described in Figures 3.2.1.9.1-1 and -2.

3.2.1.5.3.2 Accuracy Requirement

SRDC3.2.1.5.3.2-1
The absolute radiometric error of all CMIS polarimetric channels shall be consistent with meeting relevant EDR requirements listed in Section 3.2.1.1.1.1.

SRDC3.2.1.5.3.2-2
The CMIS A-level specification shall include absolute radiometric accuracy requirements for all CMIS polarimetric channels.

3.2.1.5.3.3 Unwanted Bias (TBR)

SRDC3.2.1.5.3.3-1
It shall be possible to remove any unwanted bias caused by polarization mixing, changes in polarization alignment or isolation, channel-to-channel drift or other instabilities in the CMIS sensor such that the absolute radiometric accuracy, inter-channel accuracy (if applicable) and sensitivity requirements for each CMIS channel are met.

SRDC3.2.1.5.3.3-2
Deleted.

3.2.1.6 Radiometer Transfer Function Requirements

3.2.1.6.1 Definition

3.2.1.6.1.1 Radiometer Transfer Function

The CMIS Radiometer Transfer Function is defined as the function relating, for each CMIS channel, the digitized output from that channel to the brightness temperature incident on the CMIS aperture. The CMIS Radiometer Transfer Function characterizes the radiometric response of each CMIS channel to incident microwave radiation.

3.2.1.6.1.2 Radiometer Channel Gain

The radiometer channel gain is defined as the change in digitized output of the radiometer transfer function for a 1 K change in incident brightness temperature.

3.2.1.6.2 Linearity

SRDC3.2.1.6.2-1
The CMIS A-level specification shall specify the maximum departure from an ideal linear radiometer transfer function, including the effects of quantization, and excluding non-linearity error-correction(s), for each CMIS channel radiometer transfer function in Kelvin over the specified dynamic range (see Section 3.2.1.6.3).

3.2.1.6.3 Dynamic Range

A CMIS channel's dynamic range is determined by the range of brightness temperatures in which the radiometric absolute (3.2.1.5.1) and relative (3.2.1.5.2) accuracy requirements are satisfied.

SRDC3.2.1.6.3-1
The minimum dynamic range of each CMIS channel, including the effects of quantization, shall be specified in the CMIS A-level specification in Kelvin.

SRDC3.2.1.6.3-2
The dynamic range for all CMIS channels shall allow the CMIS to meet all of the EDR requirements specified in Section 3.2.1.1.1.1.

3.2.1.6.4 Quantization Error

The Quantization error is the difference between the original (analog) and digitized quantities.

SRDC3.2.1.6.4-1
The quantization of each CMIS channel shall allow the CMIS to meet both the dynamic range (see Section 3.2.1.6.3) and the EDR requirements.

SRDC3.2.1.6.4-2
The CMIS A-level specification shall specify the maximum allowable quantization error of each CMIS channel.

3.2.1.6.5 RF Pass-band Characteristics

3.2.1.6.5.1 Definition

The pass-band bandwidth is defined as the half-power point bandwidth of the radiometer transfer function. A CMIS channel may contain one or more passbands.
The pass-band frequency stability is defined as the variability of the pass-band center frequency(ies) and bandwidth(s) of a CMIS channel's radiometer transfer function. For Doppler-corrected channels, the pass-band characteristics are referenced to each individual CMIS scan position.

3.2.1.6.5.2 Amplitude Ripple

SRDC3.2.1.6.5.2-1
The CMIS A-level specification shall specify the maximum peak-to-peak amplitude ripple of the central 80% (minimum portion of the total bandwidth centered on the pass-band center frequency) of each CMIS pass-band on a channel-by-channel basis.

3.2.1.6.5.3 Center Frequency and Bandwidth Stability

SRDC3.2.1.6.5.3-1
The stability of the center frequency and bandwidth of each CMIS RF pass-band shall enable the CMIS to meet all EDR requirements.

SRDC3.2.1.6.5.3-2
The center frequency tolerance and bandwidth tolerance for each CMIS RF pass-band shall be specified in the CMIS A-level specification on a channel-by-channel basis.

3.2.1.6.6 Gain Stability

3.2.1.6.6.1 Definition

The Gain Stability of any given channel of the CMIS is the variation, over a specified time interval, of the end-to-end radiometer gain of the given channel, as determined by the radiometer transfer function for that channel.

3.2.1.6.6.2 Short-term Gain Stability

SRDC3.2.1.6.6.2-1
The CMIS channel gain shall be stable between calibrations such that the radiometric measurement accuracy, sensitivity, and EDR requirements are met.

3.2.1.6.6.3 Long-term Gain Stability

SRDC3.2.1.6.6.3-1
Under all operational conditions, any changes in the CMIS radiometer channel gain shall not cause that channel to operate outside of its linear dynamic range. See Paragraph 3.2.1.6.3 for the definition of linear dynamic range.

3.2.1.6.6.4 Stability of Polarimetric Channels

SRDC3.2.1.6.6.4-1
The CMIS channel gain of all polarimetric channels shall be stable between calibrations to allow the CMIS to meet all relevant EDR requirements listed in Section 3.2.1.1.1.1 and the radiometric accuracy requirements listed in Section 3.2.1.5.3.

3.2.1.6.7 Channel-to-Channel Isolation

3.2.1.6.7.1 Definition

For any pair of CMIS Channels (A and B), channel-to-channel isolation is defined as the response of CMIS Channel B (in K) divided by the input to CMIS Channel A.

3.2.1.6.7.2 Requirement

SRDC3.2.1.6.7.2-1
The minimum channel-to-channel isolation associated with each CMIS channel shall be specified in the CMIS A-level specification. The CMIS A-level specification may indicate not applicable (N/A) for the channel-to-channel isolation of any pair of channels designed to have both of the following characteristics: 1) non-orthogonal polarizations and 2) RF pass-bands having common frequencies.

SRDC3.2.1.6.7.2-2
For any CMIS orthogonal channel pair the specified channel-to-channel isolation shall be no worse than the specified cross-polarization isolation.

SRDC3.2.1.6.7.2-3
Calibration, reconfiguration, and operation over the specified input signal dynamic range(s) of any combination of one or more CMIS channels shall not affect compliance with SRDC3.2.1.6.7.2-1.

3.2.1.6.8 Out-of-Band Rejection

3.2.1.6.8.1 Definition

Out-of-band rejection is the level of the end-to-end response of any CMIS channel to a signal within that CMIS channel pass-band divided by the level of the end-to-end response to signals at an equivalent input level removed from that CMIS channel pass-band by a minimum specified amount(s) and having arbitrary polarization (see Section 3.2.1.6.5 for definition of the CMIS channel pass-band).

3.2.1.6.8.2 Requirement

SRDC3.2.1.6.8.2-1
The CMIS A-level specification shall specify a minimum out-of-band rejection performance for each CMIS channel passband, on a channel-by-channel basis, at all frequencies outside of the channel passband(s).

SRDC3.2.1.6.8.2-2
The derived A-level specification shall assure that all channel performance specifications are met in the presence of any expected on-orbit out-of-band interfering signals.

3.2.1.7 Scan and Sampling Requirements

3.2.1.7.1 Number and Types of Scan Modes

SRDC3.2.1.7.1-1
The CMIS shall employ a conical scan mode.

SRDC3.2.1.7.1-2
The CMIS nadir angle shall be (TBD) ± (TBD) degrees from the CMIS vertical reference axis. (See Sections 3.2.1.8.2 and 3.2.1.12.3).

3.2.1.7.2 Swath Width and Field of Regard

3.2.1.7.2.1 Definitions (TBR)

The swath width is defined as the arc-length, in meters, along a segment of a great circle on the surface of the Earth, which is locally perpendicular to the satellite ground track and extends equally on either side of the ground track. The swath width is defined at the EDR level.
The CMIS sensor field of regard (FOR) is defined as the angular segment of the CMIS sensor's complete scan over which the CMIS is collecting radiance data from the Earth, and not including those angular segments used for calibration. The FOR is defined at the sensor level and is measured in degrees.

3.2.1.7.2.2 Requirement

SRDC3.2.1.7.2.2-1
The swath width shall meet all EDR requirements for the CMIS sensor suite.

SRDC3.2.1.7.2.2-2
The CMIS FOR shall be sufficient to provide all the data necessary to meet the CMIS EDR requirements.

3.2.1.7.3 CMIS Horizontal Spatial Resolution and Sampling (TBR)

3.2.1.7.3.1 CMIS Horizontal Spatial Resolution

3.2.1.7.3.1.1 Definition

The CMIS horizontal spatial resolution is defined in Appendix A.

3.2.1.7.3.1.2 Requirement

SRDC3.2.1.7.3.1.2-1
The CMIS horizontal spatial resolution shall be consistent with the CMIS EDR requirements in 3.2.1.1.1.1.

3.2.1.7.3.2 CMIS Horizontal Spatial Sampling

3.2.1.7.3.2.1 Along Scan

SRDC3.2.1.7.3.2.1-1
The spatial sampling frequency for each CMIS channel shall be consistent with Nyquist criteria in the along-scan direction to ensure that all scene spatial frequencies sensed by the CMIS antenna modulation transfer function (MTF) for that channel are undistorted and appear in the digitized output data for that channel.

SRDC3.2.1.7.3.2.1-2
An analysis shall be provided which demonstrates that this requirement is satisfied.

3.2.1.7.3.2.2 Along Track

SRDC3.2.1.7.3.2.2-1
The CMIS spatial sampling frequency in the along-track direction shall be consistent with the EDR requirements in Section 3.2.1.1.1.1.

SRDC3.2.1.7.3.2.2-2
The CMIS contractor shall assess the feasibility of and provide a recommendation to the government regarding Nyquist sampling in the along track direction.

3.2.1.7.3.3 Scan Rate

SRDC3.2.1.7.3.3-1
The scan rate for the CMIS conical scan shall be (TBD).

3.2.1.7.4 Pre-Sampling Filter Characteristics

SRDC3.2.1.7.4-1
The bandpass characteristics of the pre-sampling filter shall be sufficient to pass all spatial frequencies sensed by the antenna modulation transfer function without introducing distortion greater than (TBD) percent and to provide an effective integration time to meet the EDR requirements and CMIS sensor specifications for measurement sensitivity (see Section 3.2.1.4), accuracy (see Section 3.2.1.5), and horizontal spatial resolution (see Section 3.2.1.7.3).

SRDC3.2.1.7.4-2
An analysis shall be provided which demonstrates that this requirement is satisfied.

3.2.1.7.5 Scan Position Knowledge

SRDC3.2.1.7.5-1
The CMIS shall provide a measurement and readout capability to determine the angular position of the CMIS LOS in the azimuth direction relative to the satellite velocity vector.

SRDC3.2.1.7.5-2
The scan position knowledge measurement shall be accurate to (TBD) degrees and consistent with the CMIS Earth location and EDR requirements.

3.2.1.8 Antenna Requirements

3.2.1.8.1 Antenna Beam Characteristics

The antenna beam characteristics are described in terms of the Half Power Beam Width (HPBW), the main beam efficiency, pattern uniformity, and the maximum sidelobe level.

Table 3.2.1.8.1 Antenna Beam Characteristics

(TBD**)**

3.2.1.8.1.1 Antenna Half Power Beam Width

3.2.1.8.1.1.1 Definitions

The HPBW is the angular width between the two directions at which the main beam gain function is one-half its maximum value within a plane containing the maximum gain of the main beam lobe.
The CMIS channel HPBW is defined by the average of the two HPBW values measured in the planes containing the along-track and along-scan directions relative to the CMIS LOS and averaged over the CMIS channel pass-band.

3.2.1.8.1.1.2 Requirement

SRDC3.2.1.8.1.1.2-1
The individual CMIS channel HPBW values shall be sufficient to meet the EDR requirements listed in Section 3.2.1.1.1.1.

SRDC3.2.1.8.1.1.2-2
As a minimum, the HPBW requirements in Table 3.2.1.8.1 shall be met.

3.2.1.8.1.2 Main Beam Efficiency

3.2.1.8.1.2.1 Definition

The main beam efficiency of each CMIS channel is defined as the ratio of energy received in the desired polarization over the CMIS channel pass-band (for pass-band definition see Section 3.2.1.6.5.1) within 2.5 times the CMIS channel HPBW to the total amount of energy received by the antenna within the CMIS channel pass-band.

3.2.1.8.1.2.2 Requirements (TBR)

SRDC3.2.1.8.1.2.2-1
An error analysis/budget for the CMIS main beam efficiencies of all channels, which includes all relevant error sources, shall be provided to the Government.

SRDC3.2.1.8.1.2.2-2
The main beam efficiency shall be no less than the values listed in Table 3.2.1.8.1 (see section 3.2.1.8.1.4). In addition, the following requirements apply:

SRDC3.2.1.8.1.2.2-3
For all CMIS channels having a center frequency less than 12 GHz, the main beam efficiency shall be no less than 92% (TBR).

SRDC3.2.1.8.1.2.2-4
For all CMIS channels having a center frequency greater than or equal to 12 GHz, the main beam efficiency shall be no less than 95% (TBR).

SRDC3.2.1.8.1.2.2-5
For all CMIS channels primarily used for sounding, the main beam efficiency shall be no less than 95% (TBR).

3.2.1.8.1.3 Antenna Beam Uniformity

SRDC3.2.1.8.1.3-1
The HPBW in any plane containing the antenna main beam maximum gain for a given CMIS channel shall be within (TBD) percent of the CMIS channel HPBW (Section 3.2.1.8.1.1.1).

3.2.1.8.1.4 Maximum Relative Sidelobe Level (TBR)

3.2.1.8.1.4.1 Definition

The maximum relative sidelobe level is defined as the maximum value of the antenna gain function within any antenna sidelobe averaged over the CMIS channel pass-band, with respect to the maximum antenna gain averaged over the CMIS channel pass-band.

3.2.1.8.1.4.2 Requirement

SRDC3.2.1.8.1.4.2-1
The maximum relative sidelobe levels for each CMIS channel shall not be greater than the values listed in Table 3.2.1.8.1.

3.2.1.8.2 Beam Alignment (TBR)

The CMIS channel line-of-sight (LOS) vector is defined by the weighted center of the CMIS channel antenna beam's half power contour (in the CMIS sensor reference frame) averaged over the CMIS channel pass-band.

SRDC3.2.1.8.2-1
An error analysis/budget for the CMIS beam pointing accuracy and knowledge, which includes all relevant error sources, shall be provided.

3.2.1.8.2.1 Beam Pointing Accuracy

3.2.1.8.2.1.1 Along-track Requirement

SRDC3.2.1.8.2.1.1-1
The CMIS shall provide a LOS depression angle of (TBD) ± (TBD) degrees relative to the CMIS vertical reference axis (see Section 3.2.1.12.3).

SRDC3.2.1.8.2.1.1-2
The absolute along-track beam pointing error relative to the CMIS line-of-sight shall be less than or equal to ±(TBD) degrees.

3.2.1.8.2.1.2 Along-scan Requirement

SRDC3.2.1.8.2.1.2-1
The absolute, along-scan beam pointing error relative to the CMIS line-of-sight shall be less than or equal to ±(TBD) degrees.

3.2.1.8.2.2 Beam Pointing Knowledge

3.2.1.8.2.2.1 Absolute Beam Pointing Knowledge

SRDC3.2.1.8.2.2.1-1
The absolute beam pointing knowledge of each CMIS channel, with respect to the CMIS sensor reference axes, shall be less than or equal to (TBD) degrees or (TBD) percent of the antenna pattern HPBW, whichever is smaller, in both the along-track and along-scan directions.

3.2.1.8.2.2.2 Relative Beam Pointing Knowledge

SRDC3.2.1.8.2.2.2-1
The relative beam pointing knowledge of each CMIS channel shall be less than or equal to (TBD) degrees or (TBD) percent of the antenna pattern HPBW whichever is smaller for all relative measurements in both the along-track and along-scan directions.

3.2.1.8.2.3 Beam Co-registration (TBR)

SRDC3.2.1.8.2.3-1
Unless otherwise specified, the relative channel-to-channel beam pointing error shall be referenced to the (TBD) GHz channel antenna beam pattern centroid. At present the

government is considering that the reference channel will be one of the high spatial resolution imaging channels. This will aid in the validation of beam pointing and co-registration.

SRDC3.2.1.8.2.3-2
The absolute beam pointing error shall not exceed (TBD) degrees or (TBD) percent of the co-registered channel's HPBW, whichever is smaller. However, fixed beam offsets may be utilized (multiple beams), as required, in order to meet the EDR requirements (see Section 3.2.1.8.2.4).

3.2.1.8.2.4 Individual Beam Offsets

Antenna beams having fixed angular offsets from the reference channel antenna beam are allowed, as required, to meet EDR requirements (while still meeting the beam pointing knowledge requirements in section 3.2.1.8.2.2).

SRDC3.2.1.8.2.4-1
The fixed angular offset relative to the reference channel antenna beam shall be maintained to within ± (TBD) degrees.

3.2.1.8.2.5 Maximum Allowed Beam Alignment Change (TBR)

SRDC3.2.1.8.2.5-1
The maximum allowed antenna beam alignment change shall be less than (TBD) degrees or (TBD) percent of the CMIS channel HPBW.

3.2.1.9 Polarization Requirements (TBR)

3.2.1.9.1 Antenna Polarization Characteristics

3.2.1.9.1.1 Definitions

The Earth look incidence (observation) angle, θ, is the angle between the Earth's normal vector and the propagation vector. The horizontal, **h**, and vertical, **v**, polarization vectors are defined by Equations 3-1 and 3-2 (respectively) and are shown in Figure 3.2.1.9.1.1-1(a) below.

$$\mathbf{h} = \frac{\mathbf{k} \times \mathbf{n}}{|\mathbf{k} \times \mathbf{n}|} \qquad \mathbf{v} = \mathbf{h} \times \mathbf{k} \qquad \mathbf{k} = -\mathbf{r}$$

EQUATION 3-1 **EQUATION 3-2** **Equation 3-3**

where $\mathbf{n}$ is the geodetic unit normal at the Earth's surface, $\mathbf{r}$ is the boresight unit vector for a given CMIS channel, and $\mathbf{k}$ is the unit vector parallel but in the direction opposite to $\mathbf{r}$. The corresponding polarized brightness temperatures, $\mathbf{T}_v$, $\mathbf{T}_h$ are defined by Figure 3.2.1.9.1.1-1(b).

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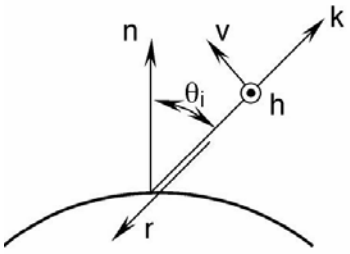

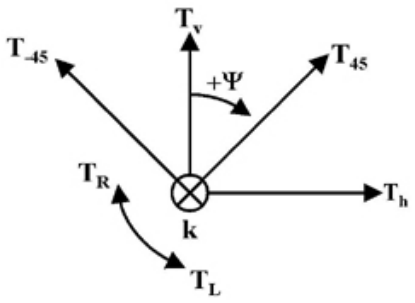

h is directed out of the page (a)

k is directed into the page (b)

FIGURE 3.2.1.9.1.1-1 Illustration of Polarized Brightness Temperatures

where $\mathbf{T}_v$ and $\mathbf{T}_h$ are the vertically- and horizontally-polarized brightness temperatures, respectively, $\mathbf{T}_{45}$ and $\mathbf{T}_{-45}$ are the 45 and −45 degree linearly-polarized brightness temperatures, respectively, and $\mathbf{T}_L$ and $\mathbf{T}_R$ are the left- and right-hand circularly polarized brightness temperatures, respectively. The angle Ψ represents the angle of orientation for linearly-polarized brightness temperatures (i.e. $\Psi = 45^\circ$ for $\mathbf{T}_{45}$), relative to **v**.

The plane of incidence, for a given CMIS channel, is defined as the plane containing the geodetic local unit normal (**n**) and the CMIS antenna beam boresight (**r**) for that channel.

Polarization basis of the CMIS Antenna: The polarization basis of the CMIS antenna is defined using $\mathbf{v}_a$ and $\mathbf{h}_a$ in the following diagram,

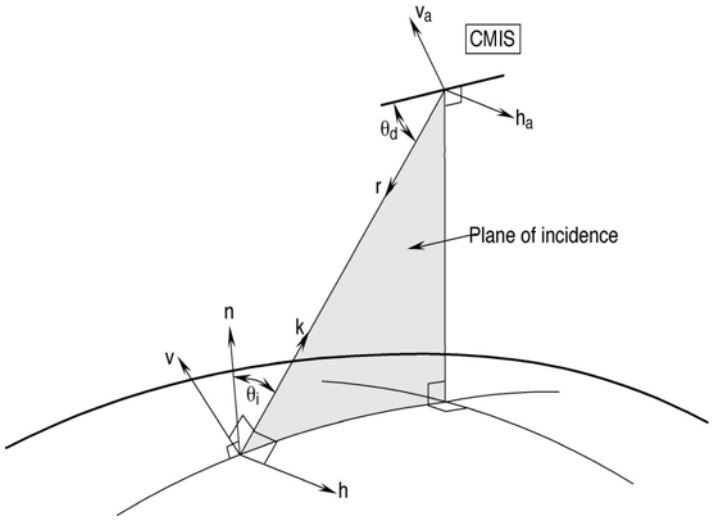

FIGURE 3.2.1.9.1.1-2. Illustration of the Relationship between the CMIS Viewing Geometry and the CMIS Antenna Polarization Basis

where, $\mathbf{v}_a$ and $\mathbf{h}_a$ are the vertical and horizontal polarization basis vectors for the CMIS . For a given CMIS channel, the following relationship holds:

$$\mathbf{r} = \mathbf{h}_a \times \mathbf{v}_a$$

EQUATION 3-4

3.2.1.9.1.2 Polarization Characteristics and Alignment

Note: Requirements applied to each CMIS channel may be unique and have unique values.

SRDC3.2.1.9.1.2-1
Each vertically-polarized CMIS channel antenna beam shall have its polarization direction lie in the plane of incidence with an uncertainty not to exceed ± (TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.1.2-2
Each horizontally-polarized CMIS channel antenna beam shall have its polarization direction normal to the plane of incidence with an uncertainty not to exceed ±(TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.1.2-3
Deleted.

SRDC3.2.1.9.1.2-4
The polarization characteristics of all CMIS channels shall be stated in the CMIS A-level specification.

3.2.1.9.1.3 Orthogonality

SRDC3.2.1.9.1.3-1
The vertically- and horizontally-polarized antenna beams shall be aligned orthogonally to within ±(TBD) degrees.

3.2.1.9.1.4 Cross Polarization Isolation

SRDC3.2.1.9.1.4-1
The integrated cross polarization rejection ratio between orthogonally -polarized CMIS channel antenna beams shall be at least (TBD) dB.

3.2.1.9.2 Antenna Polarization Requirements for Polarimetric Channels

In addition to the antenna polarization requirements in Section 3.2.1.9.1, the following requirements apply to all CMIS polarimetric channels (see Section 3.2.1.5.3 for definition of a polarimetric channel). Note: The requirements applied to each polarimetric channel may have unique values.

SRDC3.2.1.9.2-1
Deleted.

SRDC3.2.1.9.2-2
The antenna polarization(s) comprising each CMIS polarimetric channel shall be consistent with meeting EDR requirements.

SRDC3.2.1.9.2-3
Each CMIS polarimetric channel shall meet the minimum requirements for polarization alignment and cross-polarization isolation as stated below in Sections 3.2.1.9.2.1, 2, and 3.

SRDC3.2.1.9.2-4
Deleted.

3.2.1.9.2.1 Polarization of Polarimetric Channels

The values referenced in Section 3.2.1.9.2.1 may be different for each CMIS channel.

SRDC3.2.1.9.2.1-1
The polarization state shall not change by more than ±(TBD) over the CMIS scan Field Of Regard (FOR).

SRDC3.2.1.9.2.1-2
The polarization state shall be known to within ± (TBD) over the CMIS scan FOR.

3.2.1.9.2.2 Orthogonality Requirement for Polarimetric Channels

SRDC3.2.1.9.2.2-1
Deleted.

3.2.1.9.2.3 Cross Polarization Isolation Requirement for Polarimetric Channels

SRDC3.2.1.9.2.3-1
The cross polarization isolation between orthogonally-polarized CMIS channel antenna beams shall be at least (TBD) dB.

3.2.1.9.3 Polarization Purity

SRDC3.2.1.9.3-1
Each CMIS channel shall contain at least (TBD) percent of the specified polarization at the RDR level.

SRDC3.2.1.9.3-2
Deleted.

3.2.1.9.4 Polarization Error Analysis and Budget

3.2.1.9.4-1
An analysis shall be provided for each CMIS channel to demonstrate that all of the above polarization requirements are satisfied over the entire CMIS antenna FOR (for each scan

position) and which contains at a minimum, the following factors:

- CMIS internal alignment errors including the antenna subsystem alignment knowledge
- CMIS to spacecraft mounting errors
- Spacecraft attitude and ephemeris knowledge errors
- Errors caused by the Earth's oblateness (WGS-84 ellipsoid).

3.2.1.10 Calibration

SRDC3.2.1.10-1
The CMIS sensor contractor shall perform factory pre-launch (ground) calibration of the CMIS sensor as required herein.

SRDC3.2.1.10-2
The CMIS contractor shall work with the spacecraft prime contractor to determine if there exists any interference, due to the CMIS calibration system, (e.g., sun glint, RFI, etc.) with the CMIS itself or other NPOESS sensors, and work to take corrective action to mitigate these effects.

SRDC3.2.1.10-3
There shall be no time dependent feed horn effects caused by the CMIS calibration implementation, such as Voltage to Standing Wave Ratio (VSWR) changes, of such a magnitude as to cause the CMIS calibration, measurement accuracy, sensitivity and EDR requirements specified in this document not to be met.

SRDC3.2.1.10-4
The CMIS calibration system shall have view angles and other properties that are compatible with the NPOESS spacecraft and all other on-board sensors and documented in the NPOESS ICD.

SRDC3.2.1.10-5
Any on-orbit calibration techniques for the CMIS sensor shall not affect the normal operation and sensing performance of the CMIS for scene brightness temperatures.

SRDC3.2.1.10-6
The CMIS sensor design and operation shall provide for on-orbit calibration of the CMIS sensor as described herein.

3.2.1.10.1 Type of Calibration

3.2.1.10.1.1 Pre-launch Calibration

The CMIS pre-launch calibration will consist of all tests necessary to measure and characterize the radiometric measurement error of the CMIS over the range of expected on-orbit environmental conditions and the CMIS operational states and modes. The CMIS pre-launch calibration will also provide a characterization and validation of the on-orbit calibration and instrument performance. The CMIS pre-launch calibration will utilize, as required, the necessary calibration reference standards as calibration sources.

The CMIS pre-launch calibration will also provide a characterization and validation of the contractor's calibration model. The calibration model, for each CMIS channel, will be used to relate the CMIS sensor output (e.g., counts at the output of the ADC) to radiometric input (e.g., brightness temperature at the antenna aperture) over the dynamic range and operating conditions of the CMIS sensor.

3.2.1.10.1.2 On-orbit Calibration

The CMIS on-orbit calibration will consist of all hardware and measurements necessary to perform a calibration of each CMIS channel during on-orbit operations, at least once per scan.

SRDC3.2.1.10.1.2-1
The CMIS shall incorporate an on-orbit calibration system that uses a minimum of two signal levels, sufficient to cover the CMIS dynamic range, to calibrate each CMIS channel. The calibration approach may use internal, external, or any combination of sources necessary to meet the radiometric measurement accuracy requirements given in Section 3.2.1.5, and the CMIS EDR requirements. An external cold calibration source, if used, may utilize a cold space view.

SRDC3.2.1.10.1.2-2
The CMIS contractor shall provide, to the spacecraft contractor, for inclusion into the ICD, the necessary information and requirements to accommodate the clear field of view required by a view of cold or deep space.

3.2.1.10.2 Frequency of Calibration

3.2.1.10.2.1 Pre-launch Calibration

SRDC3.2.1.10.2.1-1
The pre-launch calibration shall be performed prior to CMIS delivery.

SRDC3.2.1.10.2.1-2
If the period between delivery of the CMIS and integration onto the spacecraft exceeds (TBD) months, then the pre-launch calibration shall be repeated before integration onto the spacecraft.

SRDC3.2.1.10.2.1-3
If the CMIS has been in storage prior to spacecraft integration for longer than (TBD) months, then the pre-launch calibration shall be repeated before integration onto the spacecraft.

SRDC3.2.1.10.2.1-4
If the CMIS has been in storage after integration onto the spacecraft for longer than (TBD) months, then the contractor shall make recommendations for any pre-launch calibration or performance verification requirements.

3.2.1.10.2.2 On-orbit Calibration

SRDC3.2.1.10.2.2-1
Calibration data for each CMIS channel shall be obtained at least once per scan.

SRDC3.2.1.10.2.2-2
The number of calibration samples taken during each scan shall be sufficient to meet all radiometric measurement accuracy, sensitivity, and EDR performance requirements.

3.2.1.10.3 Calibration Source Requirements

3.2.1.10.3.1 Pre-launch Calibration

SRDC3.2.1.10.3.1-1
External thermal calibration sources suitable for the pre-launch calibration of all CMIS channels shall be provided by the CMIS contractor. The external thermal calibration sources will be referred to as calibration targets or loads. These calibration targets are intended to approximate Blackbody radiance sources.

3.2.1.10.3.1.1 Pre-launch Calibration Target Emissivity

SRDC3.2.1.10.3.1.1-1
The pre-launch calibration target(s) shall have a minimum measured emissivity of (TBD), for each CMIS channel.

SRDC3.2.1.10.3.1.1-2
A detailed description of the pre-launch calibration target emissivity measurement procedures and data shall be documented and supplied to the government.

3.2.1.10.3.1.2 Pre-launch Calibration Target Range of Brightness Temperatures

SRDC3.2.1.10.3.1.2-1
The pre-launch calibration targets shall be capable of providing standard reference brightness temperatures over the temperature range (TBD) K to (TBD) K at all the CMIS operational frequencies.

3.2.1.10.3.1.3 Pre-launch Calibration Target Temperature

This section discusses requirements on the physical temperature of the pre-launch calibration targets.

SRDC3.2.1.10.3.1.3-1
Temperature differences between any temperature controlled surface and the surface viewed by the CMIS radiometer channels shall be less than (TBD) K.

SRDC3.2.1.10.3.1.3-2
The temperature of the pre-launch calibration target shall be continuously monitored during all calibration tests using NIST traceable temperature transducers.

SRDC3.2.1.10.3.1.3-3
The temperature measurements of the pre-launch calibration target(s) shall have an uncertainty no greater than ± (TBD) K.

3.2.1.10.3.1.4 Pre-launch Calibration Target Brightness Temperature Uniformity

Brightness temperature uniformity refers to both the spatial and temporal variation of the calibration targets during the pre-launch calibration testing.

SRDC3.2.1.10.3.1.4-1
The maximum brightness temperature variation over the effective aperture of the pre-launch calibration target(s), corresponding to a given CMIS channel, shall be less than (TBD) K at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2. The effective aperture of the pre-launch calibration target, corresponding to a given CMIS channel, is defined as the 90 percent energy contour of the corresponding feedhorn antenna under test, for that channel. Note that this is a requirement on the spatial uniformity of the calibration target(s).

SRDC3.2.1.10.3.1.4-2
The maximum brightness temperature variation of the pre-launch calibration target(s) shall be constant to within (TBD) K during the pre-launch calibration, at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2. Note that this is a requirement on the temporal uniformity of the calibration target(s) during the pre-launch calibration tests.

3.2.1.10.3.1.5 Pre-launch Polarimetric Calibration Source Requirements (TBR)

SRDC3.2.1.10.3.1.5-1
The pre-launch calibration shall ensure that calibration of all polarimetric channels is consistent with CMIS EDR algorithm requirements.

SRDC3.2.1.10.3.1.5-2
Deleted.

SRDC3.2.1.10.3.1.5-3
Deleted.

SRDC3.2.1.10.3.1.5-4
Deleted.

3.2.1.10.3.1.6 Pre-launch Calibration of Internal Calibration Source(s)

SRDC3.2.1.10.3.1.6-1
If the CMIS sensor utilizes internal calibration source(s), the internal calibration source performance shall be verified by an end-to-end (through the feed) calibration with an external calibration target over the range of brightness temperatures specified in Section 3.2.1.10.3.1.2.

3.2.1.10.3.2 On-orbit Calibration

SRDC3.2.1.10.3.2-1
The calibration sources employed for on-orbit calibration of the CMIS shall provide brightness temperatures or noise powers sufficient to enable the CMIS to meet all

radiometric measurement accuracy requirements in Section 3.2.1.5, and the EDR requirements in Section 3.2.1.1.1.1.

3.2.1.10.3.2.1 On-orbit Calibration Target Emissivity

SRDC3.2.1.10.3.2.1-1
Any on-orbit calibration targets shall have a measured emissivity of (TBD).

SRDC3.2.1.10.3.2.1-2
A detailed description of all on-orbit calibration target emissivity measurement procedures and data shall be documented and supplied to the government.

3.2.1.10.3.2.2 On-orbit Calibration Target Range of Brightness Temperatures

SRDC3.2.1.10.3.2.2-1
The external on-orbit calibration target shall be capable of providing brightness temperatures over the temperature range (TBD) K to (TBD) K.

3.2.1.10.3.2.3 On-orbit Calibration Target Temperature

This section discusses requirements on the physical temperature of the on-orbit calibration target.

SRDC3.2.1.10.3.2.3-1
Temperature differences between any temperature controlled surface and the surface viewed by the CMIS radiometer channels shall be less than (TBD) K.

SRDC3.2.1.10.3.2.3-2
The temperature of any on-orbit external calibration target shall be continuously monitored using NIST traceable temperature transducers.

SRDC3.2.1.10.3.2.3-3
The temperature measurements of the on-orbit calibration target(s) shall have an uncertainty no greater than ± (TBD) K.

3.2.1.10.3.2.4 On-orbit Calibration Target Brightness Temperature Uniformity

Brightness temperature uniformity refers to both the spatial and temporal variation of the calibration targets during on-orbit calibration measurements.

SRDC3.2.1.10.3.2.4-1
The maximum brightness temperature variation over the effective aperture of the on-orbit calibration target(s), corresponding to a given CMIS channel, shall be less than (TBD) K at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2. The effective aperture of the on-orbit calibration target, corresponding to a given CMIS channel, is defined as the 90 percent energy contour of the corresponding feedhorn antenna under test, for that channel. Note that this is a requirement on the spatial uniformity of the calibration target(s).

SRDC3.2.1.10.3.2.4-2
The maximum brightness temperature variation of the on-orbit calibration target(s) shall be less than (TBD) K during the on-orbit calibration, at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2. Note that this is a requirement on the temporal uniformity of the calibration target(s) during the on-orbit calibration measurements that occur at least once per scan.

3.2.1.10.3.2.5 On-orbit Internal Calibration Source Requirements

SRDC3.2.1.10.3.2.5-1
If internal calibration sources are to be used on-orbit, the calibration of the CMIS channels utilizing the internal calibration sources shall meet the radiometric measurement accuracy (Section 3.2.1.5) and EDR performance requirements.

3.2.1.10.4 Calibration Error Analysis

3.2.1.10.4.1 Pre-launch Calibration

SRDC3.2.1.10.4.1-1
An error analysis/budget for the CMIS pre-launch calibration, which includes all relevant error sources to the pre-launch calibration, shall be provided to the government.

SRDC3.2.1.10.4.1-2
The following error sources shall be included as a minimum:

- Calibration target temperature uniformity and measurement error
- Non-blackbody emissivity of calibration target
- Imperfect coupling between the feedhorn and calibration targets (e.g., unwanted energy entering the feedhorn)
- Cross-polarization coupling errors
- Antenna feedhorn spillover
- Feedhorn to reflector alignment errors
- Antenna reflector emissions
- Quantization error
- The effect of incident radiation outside of the feedhorn antenna’s 90 percent energy contour (sidelobe effects)
- Non-linear radiometer transfer function

3.2.1.10.4.2 On-orbit Calibration

SRDC3.2.1.10.4.2-1
An error analysis/budget for the CMIS on-orbit calibration which includes all relevant error sources to the on-orbit calibration shall be provided to the government.

SRDC3.2.1.10.4.2-2
The error sources shall include as a minimum those identified in Section 3.2.1.10.4.1.

3.2.1.11 Doppler Correction or Tracking

The CMIS contractor should consider the effects of the relative motion of the satellite and CMIS sensor scan LOS on the retrieval of atmospheric EDRs.

SRDC3.2.1.11-1
The CMIS contractor shall account for these effects in either the CMIS hardware design or science algorithms or both.

3.2.1.12 Earth Location Requirements

3.2.1.12.1 Definition

The alignment of the CMIS relative to the spacecraft, and knowledge of the CMIS LOS in conjunction with the spacecraft attitude and ephemeris data, will allow the Earth location of the CMIS sensor data.

SRDC3.2.1.12.1-1
The Earth location shall be in geodetic latitude and longitude, corrected for altitude within the accuracy specified for each EDR in Section 3.2.1.1.1.1.

3.2.1.12.2 Requirements

3.2.1.12.2.1 Allocations

SRDC3.2.1.12.2.1-1
The CMIS contractor shall be responsible for meeting the EDR Earth location requirements, based on the allocations from the spacecraft level as specified in Section 3.2.4.2.1.3.

SRDC3.2.1.12.2.1-2
The CMIS contractor shall provide a complete analysis of the Earth location error budget.

SRDC3.2.1.12.2.1-3
This shall include, but is not limited to, the allocations from the spacecraft, the CMIS sensor design allocations, alignment requirements between the CMIS and the spacecraft, and development and validation of the Earth location algorithm for the CMIS data.

SRDC3.2.1.12.2.1-4
The CMIS contractor shall communicate all data requirements necessary to perform this function to the IPO and prime contractor.

TABLE 3.2.1.12.2 EARTH LOCATION REQUIREMENTS ERROR BUDGET

(TBD)

3.2.1.12.3 Sensor Reference Axes Alignment

SRDC3.2.1.12.3-1
The CMIS shall have a well-defined set of three orthogonal reference axes.

SRDC3.2.1.12.3-2
This set shall include a vertical reference axis.

SRDC3.2.1.12.3-3
These axes shall be used as reference axes for alignment of the CMIS LOS and the overall alignment of the CMIS to the NPOESS spacecraft. (See paragraph 3.2.1.8.2.1).

SRDC3.2.1.12.3-4
Any additional reference positions and alignment axes shall be determined by the CMIS contractor and provided to the IPO and prime contractor.
(**TBD**)

3.2.1.12.4 CMIS Line-of-Sight (LOS) Pointing Knowledge
(**TBD**)

3.2.1.12.5 CMIS LOS Jitter and Drift Requirements

3.2.1.12.5.1 Definition of Jitter
(**TBD**)

3.2.1.12.5.2 Requirements
(**TBD**)

3.2.1.12.5.3 Definition of Drift
(**TBD**)

3.2.1.12.5.4 Requirements
(**TBD**)

3.2.1.13 Standard Earth Scenes
Deleted.

3.2.1.14 Data Formatting and Compression (TBR)

SRDC3.2.1.14-1
The data packets generated by the CMIS shall conform to the Consultative Committee for Space Data Systems (CCSDS) packetization per the (TBD) real time interface specification and the (TBD) stored data interface specification.

SRDC3.2.1.14-2
If data compression techniques are utilized by the CMIS in generating data packets for storage on-orbit, the compression shall be lossless.

SRDC3.2.1.14-3
The CMIS may utilize lossy data compression in generating data packets for real-time transmission of mission data to field terminals via either high or low data rate links, with the exception of sensor calibration data.

SRDC3.2.1.14-4
If the CMIS utilizes data compression techniques in generating data packets for real time transmission of sensor calibration data to field terminals, via either high or low data rate links, the compression shall be lossless.

SRDC3.2.1.14-5
The CMIS contractor shall identify and quantify any EDR performance degradation at the field terminals resulting from the use of lossy data compression.

3.2.1.15 Mission Reliability

Mission reliability is the probability that the sensor suite shall provide the necessary RDR data to retrieve CMIS EDR's at threshold performance levels. For EDRs where the contractor proposes to deliver performance below threshold levels, the Mission Reliability shall be judged against the proposed EDR performance level.

SRDC3.2.1.15-1
The sensor suite's mission reliability shall be as specified in the following table at the end of a 7 year life and including an 8 year storage period.

EDR Category	Threshold	Objective
Launch Critical Category IA (Sea Surface Winds-Speed, Soil Moisture)	0.86	TBD
Other Category IA (Atmospheric Vertical Moisture Profile), and Category IIA	TBD	TBD
Categories IIB, IIIA and IIIB	TBD	TBD

3.2.2 SENSOR CAPABILITY RELATIONSHIPS

3.2.2.1 Reference Timelines

TBD

3.2.3 INTERFACE REQUIREMENTS

The system interfaces relevant to the sensors are depicted in Figure 3.2.3 below:

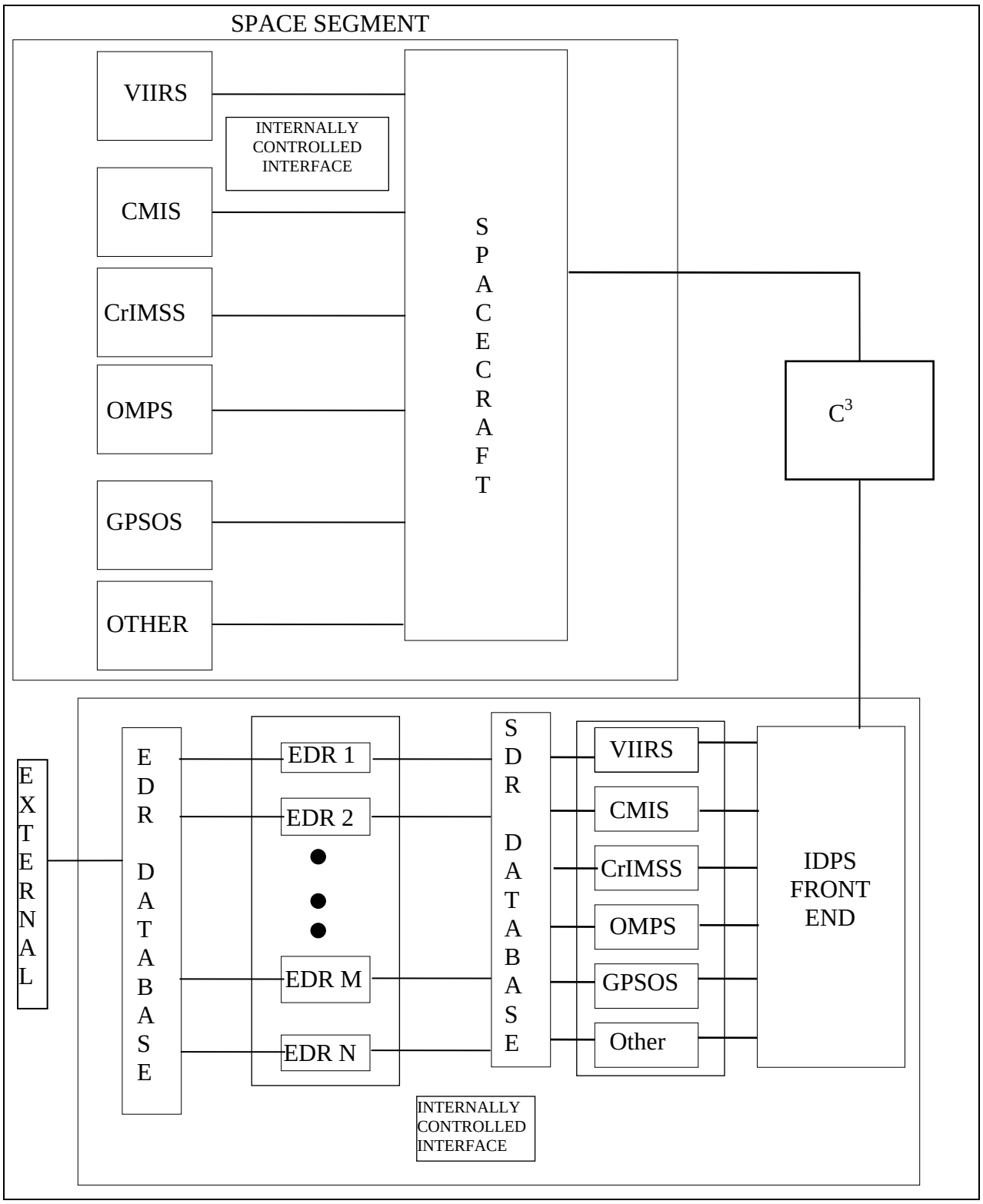

Figure 3.2.3 Partial System Internal Interfaces

3.2.4 PHYSICAL AND INTERFACE CHARACTERISTICS

The weight, power, volume and data rates described herein represent the Goal, Target, and Not-to-Exceed values for the CMIS instrument. The Goal values represent the lowest realistic values developed during initial studies at the Integrated Program Office (IPO). The Target values represent the most probable estimate of the particular CMIS parameter, while the Not-to-Exceed values represent the maximum acceptable values for the CMIS instrument. Relaxation of the Not to Exceed requirement will only be possible if changes are consistent with the requirement to accommodate the full NPOESS payload suite of instruments on a spacecraft which can be placed in a nominal 833 km orbit by an EELV-class launch vehicle.

The CMIS notional baseline provides for the CMIS to be mounted on the zenith surface of the NPOESS spacecraft in order to prevent intrusions into the fields of view of other sensors. Alternative mounting locations will be considered by the NPOESS Program, but will not be approved until satisfactory accommodation of other sensors on the spacecraft has been demonstrated.

The spacecraft-to-sensor interface requirements are broken down into four primary groups: mechanical, power, data, and thermal. A notional diagram of the top-level functional interfaces for any sensor is shown in Figure 3.2.4. In addition, environmental, software, testing, contamination, launch environment, and safety requirements are defined.

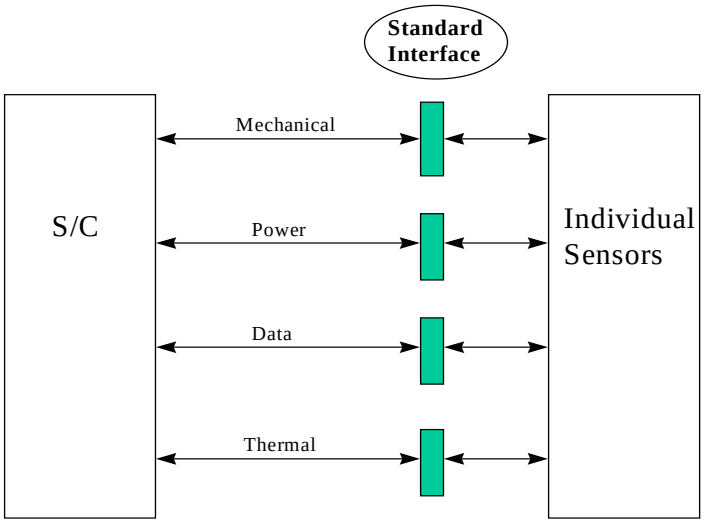

Figure 3.2.4. Notional Spacecraft-To-Sensor Functional Interfaces.

3.2.4.0.1 Deleted

SRDC3.2.4.0.1-1 DELETED.

SRDC3.2.4-1
The Goal, Target, and Not-to-Exceed values for the complete CMIS sensor mass (including all subsystems, deployment mechanisms, mounting hardware, cabling, etc.) are given in Table 3.2.4a. The mass of the complete CMIS sensor (including all subsystems, deployment mechanisms, mounting hardware, cabling, etc.) shall be less than the Not-to-Exceed value specified in Table 3.2.4a.

CMIS Mass	kg
Goal	201
Target	250
Not-to-Exceed	275

Table 3.2.4a CMIS sensor Mass

3.2.4.0.2 Deleted

SRDC3.2.4.0.2-1 DELETED

SRDC3.2.4-2
The notional CMIS consists of an antenna, rotating electronics canister, required momentum compensation, and additional electronics packages (if necessary). The values listed for the rotating electronics canister are considered to be the stowed dimensions of the canister, including any necessary deployment mechanisms. The Goal, Target, and Not-to-Exceed values for the dimensions of the CMIS sensor components are given in Table 3.2.4b. The dimensions of the CMIS sensor subsystems shall be less than the Not-to-Exceed values specified in Table 3.2.4b.

CMIS Dimensions	Antenna Subassembly Dimension* (cm)	Electronics Canister (cm)	Additional Electronics Packages (cm)	Momentum Compensation Unit (cm)
Goal	220	46 x 46 x 55 (x,y,z)	TBD	TBD
Target	250	TBD	TBD	TBD
Not-to-Exceed	TBD	TBD	TBD	TBD

* Largest Stowed Dimension including mounting fixtures and other necessary hardware

Table 3.2.4b CMIS Sensor Dimensions

SRDC3.2.4-3
The swept volume of the deployed and nominally operating CMIS electronics canister and antenna subsystem shall be less than (TBD).

3.2.4.0.3 Deleted

SRDC3.2.4.0.3-1 DELETED.

SRDC3.2.4-4

The Goal, Target, and Not-to-Exceed values for the CMIS orbit average power consumption are given in Table 3.2.4c. The orbital average power consumption of the complete CMIS sensor (including all subsystems, electronics packages and momentum compensation) shall be less than the Not-to-Exceed value specified in

Table 3.2.4c.

CMIS Power	Watts
Goal	208
Target	227
Not-to-Exceed	340

Table 3.2.4c CMIS sensor Power

SRDC3.2.4-5

The peak power consumption and duration of the nominally operating CMIS sensor shall be specified in the contractor System-Spec.

3.2.4.0.4 Deleted

SRDC3.2.4.0.4-1 DELETED.

SRDC3.2.4-6

The Goal, Target, and Not-to-Exceed values for the CMIS sensor data rate are given in Table 3.2.4d. The data rate values are intended to be uncompressed, orbital averages. The uncompressed, orbital average CMIS sensor data rate shall be less than the Not-to-Exceed value specified in Table 3.2.4.d.

CMIS Data Rate	kbps
Goal	160
Target	300
Not-to-Exceed	500

Table 3.2.4d CMIS sensor Data Rate

SRDC3.2.4-7

The peak data rate, during nominal operation of the CMIS sensor, shall be specified in the contractor System/Subsystem-Spec.

3.2.4.0.5 Deleted.

Continued in Common Section